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ABSTRACT

The mathematical derivation of the statistics used for inference in some linear models assumes that the values of the independent variables are measured without error. This assumption is often disregarded when these models are utilized in research. This study is an investigation of the consequences of the violation of this assumption for one family of linear models on the magnitude of these statistics and the frequency of Type I error in these models. The results of this study indicate that although the frequency of Type I error in these models is relatively unaffected, the values of the statistics are seriously affected by the concomitant variable being other than error-free. (Author)

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ABSTRACT

AN EMPIRICAL INVESTIGATION OF SOME EFFECTS OF THE VIOLATION OF THE ASSUMPTION THAT THE COVARIABLE IN ANALYSIS OF COVARIANCE IS MEASURED WITHOUT ERROR

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The mathematical derivation of the statistics used for inference in some linear models assumes that the values of the independent variables are measured without error. This assumption is often disregarded when these models are utilized in research. This study is an investigation of the consequences of the violation of this assumption for one family of linear models on the magnitude of these statistics and the frequency of Type I error in these models. The results of this study indicate that the frequency of Type I error in these models is relatively unaffected, and the values of the statistics are probably not seriously affected by the concomitant variable being other than error free. However, an inadequacy in the procedure cause any conclusions to be of a tentative nature.

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AN EMPIRICAL INVESTIGATION OF SOME EFFECTS OF THE VIOLATION OF THE ASSUMPTION THAT THE COVARIABLE IN ANALYSIS OF COVARIANCE IS MEASURED WITHOUT ERROR[1]

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R. A. Fisher, who conceived the statistical technique analysis of covariance (Fisher, 1932), stated that "it [analysis of covariance] combines the advantages and reconciles the requirements of two widely applicable procedures known as regression and analysis of variance" (Fisher, 1973, p. 283). Although this combination of regression and analysis of variance is obvious in most presentations of analysis of covariance from an applications point of view, the contributions of regression to the set of assumptions for analysis of covariance are seldom mentioned. This study involves two of the often neglected assumptions of analysis of covariance which stem from the role played by regression.

In a linear model context analysis of covariance can be thought of as a data reduction procedure in which characteristics or performance of objects or individuals can be described in terms of statistics which occur as coefficients in an appropriate linear model and as an inferential procedure for contrasting certain of the statistics which have been obtained by the solution of the model for a particular set of data. In such a data

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[1]This paper represents a report of one aspect of a continuing empirical research effort concerning certain aspects of the analysis of covariance procedure. The author would like to recognize and thank the following persons for their various contributions to this research: Marshall Adams, Jacqueline W. Calkins, Lorraine Matteson, Eugene Schuster, and the computation center staff at The University of Texas at El Paso.

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reduction procedure, the statistics describing the characteristics or performances of objects or individuals classified in a particular manner by a given value or given values of the independent variable or variables can be seen to be based on the attributes of a joint frequency distribution of the dependent variable and concomitant variable(s). Such statistics are obtainable through the mathematical fit of an appropriate function to the space generated by the data occurring for the dependent variable and concomitant variable(s) for each grouping of objects or individuals defined by a particular value of the independent variable or by particular values of the independent variables.

Comparison of objects or individuals classified in a particular manner by a value of the independent variable or values of the independent variables can be visualized geometrically as comparison of these joint frequency distributions and more specifically as comparison of the attributes of the mathematical functions obtained for each frequency distribution. Such comparisons of these groups can be quantitatively accomplished in terms of assessing the probability that differences among the appropriate statistics which occur in the linear model as summaries of the frequency distributions do not exist for the populations from which the groups were obtained. These probabilities can be obtained through evaluation of F statistics which are calculable as functions of the amount of error in one model in which differences in the appropriate statistics are allowed to exist and another model which has been constrained to eliminate the differences to be examined.

The simplest case of analysis of covariance is the most usual application of this technique. In this case there is a single concomitant variable and a single independent variable, and a linear relationship is the most appropriate mathematical function with which to fit the data for each group. Since the latter condition implies that the relationship between the dependent variable

and the concomitant variable is linear, it can be readily seen that a true model for this case must contain an intercept and a slope for each value of the independent variable. Obviously, comparisons among the various groups, which are defined by the independent variable, must be accomplished in terms of differences among the group slopes and intercepts.

The following procedure is intended to demonstrate how such comparisons can be accomplished when certain assumptions involving the variables are met. To test for differences among the group slopes, the F statistic from the expression

$$F_{slopes} = \frac{(q_2 - q_1) / df_1}{q_1 / df_2}$$

can be calculated and evaluated where q_1 is the error sum of squares for the true model which contains a slope and intercept for each group; q_2 is the error sum of squares for a model which contains an intercept estimate for each group but the same slope estimate for all groups (this restricted model constrains each group to have the same slope, thus eliminating all group slope differences); df_1 is a number with a magnitude one less than the number of groups; and df_2 is a number with a magnitude equal to the summation of the number in each group reduced by two (Ward and Jennings, 1973, pp. 138-148). To test for differences among the group intercepts when the group slopes are not different, the F statistic from the expression

$$F_{intercepts} = \frac{(q_3 - q_2) / df_1}{q_2 / df_3}$$

can be calculated and evaluated where q_2 is the error sum of squares for the restricted model presented above; q_3 is the error sum of squares for a model which contains the same intercept estimate and the same slope estimate for each group (this further restricted model constrains each group to have the same intercept and the same slope, thus eliminating all group intercept and

group slope differences); df_1 is a number (as above) with a magnitude one less than the number of groups; and df_3 is a number with a magnitude equal to the summation of the number in each group reduced by a number one less than the number of groups (Ward and Jennings, 1972, pp. 138-148).

Although particular interpretations of differences among group slopes and intercepts depend upon particular situations, some general interpretations are as follows:

1. The occurrence of differences in the group slopes implies that the rate of change of the dependent variable with respect to the concomitant variable differes for the various groups.
2. The occurrence of differences in the group intercepts when the group slopes are not different implies that there are constant differences among the groups in terms of the dependent variable for each value of the concomitant variable.

Generally comparisons of group intercepts are of little interest if the group slopes are different, because in this situation differences among the groups are variable, since the difference depends on particular values of the concomitant variable.

In order to show the inherent distributional assumptions involving the variables for analysis of covariance when there is only a single concomitant variable, the relationship between the dependent and concomitant variables is linear, the group slopes are not different, and there is only one independent variable, the following model for analysis of covariance as presented by Graybill (1961, pp. 383-384) will be used. "The model is

$$y_{ij} = \mu + \tau_i + \beta x_{ij} + e_{ij} \qquad \begin{matrix} j = 1, 2, \ldots r \\ i = 1, 2, \ldots t \end{matrix}$$

where y_{ij} is an observed random variable; x_{ij} is an observed fixed quantity, usually called a concomitant variable; μ is a constant; τ_i is the ith treatment constant; β is the regression coefficient (unknown); and e_{ij} are unobserved

normal variables that are independent and have means 0 and constant variances σ^2." Examination of this model and its assumed distributional properties reveals that (1) the dependent variable $\underline{y}$ is assumed to be a random variable measured without error; (2) the concomitant variable $\underline{x}$ is assumed to be a fixed variable measured without error; and (3) β is a constant for all treatment groups. The model is essentially the one discussed previously in which all groups were constrained to have the same group slope.

In addition, Graybill (1961, pp. 384-396) shows that when the data conform to the distributional assumptions of the model, many desirable mathematical properties result. It is only as a consequence of these resulting mathematical properties that the descriptive and inferential uses of analysis of covariance are viable. Unfortunately, it seems that little pertinent research by the mathematical statisticians is available to indicate what consequences are to be expected when the data do not conform to the distributional assumptions of the model.

For the usual application of such models by researchers, the assumptions involving error free measurement of the dependent and concomitant variables and the necessity that the concomitant variable be a fixed variable are often neglected. Previous research (Calkins and Jennings, 1972) has indicated that the consequences of the violation of the assumption that the concomitant variable is fixed are probably of little practical importance to investigators concerned with estimation of slopes and intercepts and Type I error resulting from contrasts of slopes and intercepts. In the research presented in this paper, some of the consequences of the violation of the assumptions that the concomitant variable is quantified in an error free manner and that the concomitant variable is fixed and quantified in an errorless manner have been investigated.

PROCEDURE

This research was conducted in much the same manner using essentially the same computer programs as the previous investigation in this series (Calkins and Jennings, 1972). Since complete details of the procedure were presented in the previous investigation, this procedure section will be abbreviated, and persons interested in more details may consult that paper.

The set of models investigated are those discussed previously in this paper in which the true model contains one independent variable and one concomitant variable which is linearly related to the dependent variable. The investigation of the effects which occur in these models when the concomitant variable contains error, or contains error and is not a fixed variable, was restricted to possible disturbance of (1) the distributions of the slopes and intercepts, and (2) the distributions of the $\underline{F}$ statistic utilized for decisions concerning possible differences in the slopes and intercepts. Possible disturbance of the distributions of the slopes and intercepts were examined through the calculation of functions of the first four cumulative moments of their respective distributions, the mean, variance, skewness and kurtosis. Theoretically it is expected that the slopes and intercepts will be distributed normally with the following values:

$$\text{Expected mean for slopes} = \frac{\rho_{xy} \cdot \sigma_y}{\sigma_x}$$

$$\text{Expected variance for slopes} = \frac{\sigma_y^2 (1 - \rho_{xy}^2)}{\sigma_x^2 \ (n - 2)}$$

$$\text{Expected mean for intercepts} = \mu_x - \frac{\rho_{xy}\sigma_y}{\sigma_x} \ \mu_y$$

$$\text{Expected variance for intercepts} = \frac{n}{2(n-1)^2} \ \frac{\sigma_y^2}{\sigma_x^2} \ (1 - \rho_{xy}^2) \ (\sigma_x^2 + \mu_x^2)$$

(approximate formula)

where n is the sample size

ρ_{xy} is the correlation for the population

μ_x and μ_y are the marginal population means for the x and y populations

σ_x and σ_y are the marginal population standard deviations for the x and y populations.

Possible disturbance of the distributions of the F statistic utilized for decisions concerning possible differences in the slopes and intercepts were examined through comparison of the mean of the observed sampling distributions with the theoretical values and comparison of the number of observed values for the distributions of F's for slope and intercept which were equal to or greater than the specific values of the central F distribution for the proper degrees of freedom at the .05 and .01 confidence levels. Since in this investigation all the samples were drawn from the same population, the expected values of $F_{intercept}$ should be near $df_3/(df_3 - 2)$ and F_{slope} should be near $df_2/(df_2 - 2)$ where df_2 and df_3 were previously defined in this paper. In addition, approximately five per cent of the values observed for $F_{intercept}$ and F_{slope} should be equal to or greater than the specific values of the central F distribution for the appropriate degrees of freedom at the .05 level and approximately one per cent should be equal to or greater than the equivalent value at the .01 level.

This empirical research, which was performed with the indispensable help of a digital computer, is of the Monte Carlo type. The computer system utilized was a CDC 3150 located at The University of Texas at El Paso. The FORTRAN programs written for this series of investigations function to (1) generate multiple pairs of values which simulate random samples of X,Y pairs from bivariate populations of values with various characteristics; (2) combine these pairs of values into samples of specified size; (3) calculate various quantitative indices on the data for and between the samples which correspond

to the quantitative indices resulting from the descriptive and inferential use of the linear models presented previously; (4) tabulate these indices for a specified number of experiments, each including a specified number of samples, in order to obtain a frequency distribution for each index; (5) calculate descriptive characteristics for each frequency distribution; and (6) produce output showing the frequency distributions and their descriptive characteristics. In this procedure, error in the covariable was introduced by generating a pair of X and Y values which had suitable characteristics for a certain condition of the experiment and then adding a component of error which was a random normal deviate from a population with zero mean and specified variance to each X value.

The characteristics of the bivariate populations which are specifiable with this set of programs and which were varied in this investigation are (1) sampling procedure for the covariable (random or fixed); (2) distribution shape of the covariable (normal or rectangular); (3) amount of error in the covariable (in terms of the standard error of measurement as a function of percent of standard deviation of Y -- 0%, 33%, 67%, and 100%); (4) variance of the Y values in each X array (in terms of standard error of estimate as a function of correlations of .0, .30, .60, and .90); and (5) sample size (samples of 5, 13 and 39 X,Y pairs were used). The characteristics of the bivariate populations which are specifiable but were not varied in this investigation are (1) means of the X and Y marginal distributions (maintained at or near 50); (2) number of groups obtained for each experiment (each experiment consisted of the data obtained for two groups with each group containing either 5, 13 or 39 X,Y pairs); and (3) number of experiments (1000 experiments were conducted for each of the possible combinations of the characteristics of the bivariate populations).

It was intended that the standard deviations of the X and Y marginal distributions be maintained at or near 10., but procedural constraints interfered to some extent. However, as an attempt to compensate for this lack of control, two sets of theoretically expected values for the mean and variance of the distributions of slope and intercept are presented in the Results section; one set is based on the intended population values and the other set is based on observed values. Comparison of these values should indicate to some degree the extent of this problem or the adequacy of the entire procedure.

Since it is always desirable in any scientific enterprise to maintain constant as many variables as possible, in this series of investigations it would be desirable to maintain constant the X variance for all experimental conditions. However, these constant variances are difficult to achieve, especially for the fixed X condition (at least from the author's current cognitive set). This difficulty occurs because for the fixed X case it must be decided whether it is more important to maintain a constant variance for the covariable or to use the same fixed X values for the various sample sizes. In the first investigation in this series (Calkins and Jennings, 1972), the same set of X values were used for all the fixed X cases for the two distribution shapes by varying the frequency of occurrence of each X value, but in this procedure the variances of the X values were allowed to vary. (The peculiar choice of X,Y pairs per sample -- 5, 13 and 39 -- is a byproduct of this procedure.) In the present investigation, a compromise between maintaining constant variance and the same set of fixed X values was effected, and as a consequence neither objective was fully attained. In this investigation fairly constant variance for the zero error condition was achieved by allowing the set of fixed X's to differ for different sample sizes, but when the X values contained a component of error the variance of the X values was to some extent uncontrolled. Some control over the variance

in this procedure could be established by a linear transformation of the X values containing error by subtracting a different constant for each quantity of error and each sample size, but such a transformation would destroy the concept of one set of fixed $\underline{X}$'s for all experimental conditions. (The author would appreciate comments concerning this problem.)

RESULTS

The results are presented in Tables 2 through 25. Tables 2-5 present the results of the experiments involving the investigation of the distributions of slopes for the several experimental conditions for the concomitant variable normally distributed with each table representing a particular value of error of estimate. Table 6-9 contain the same information as Tables 2-5 except that in these tables the concomitant variable is uniformly (rectangularly) distributed. Tables 10-13 present the results of experiments involving the investigation of the distributions of intercept for the several experimental conditions for the concomitant variable normally distributed with each table representing a particular value of error of estimate. Tables 14-17 contain the same information as Tables 10-13 except that in these tables the concomitant variable is uniformly (rectangularly) distributed. Tables 18-21 present the results involving the critical statistics for comparison of slopes and intercepts for the several experimental conditions for the concomitant variable normally distributed with each table representing a particular value of error of estimate. Tables 22-25 contain the same information as Tables 18-21 except that in these tables the concomitant variable is uniformly (rectangularly) distributed. Table 1 presents explication of the terms and abbreviations found in Tables 2-25.

Proper interpretation of these results can reveal the consequences of three aspects of the violation of assumptions concerning the concomitant

TABLE 1

Explication of Terms and Abbreviations
Found in Tables 2 through 25

1. Expect T - expected values based on specified characteristics of the bivariate populations

2. Expect O - expected values based on observed characteristics of the populations (example - the expected value for intercepts is calculable by subtracting the mean of the frequency distribution containing 2000 slopes multiplied by the mean of the frequency distribution containing 2000 X marginal means from the mean of the frequency distribution containing 2000 Y marginal means)

3. Error - standard error of measurement as a function of percent of standard deviation of Y values

4. RN - values of X (the concomitant variable) were obtained by random sampling from a normal distribution

5. FN - values of X (the concomitant variable) were preselected (fixed) such that they have zero skewness and kurtosis

6. RR - values of X (the concomitant variable) were obtained by random sampling from a uniform (rectangular) distribution

7. FR - values of X (the concomitant variable) were preselected (fixed) such that the values have equal frequency (rectangularly distributed)

8. Mean F - mean value of the observed frequency distribution of F values

9. I-Error - number of Type I errors observed at the .05/.01 level of significance

2 SOME CHARACTERISTICS OF THE SAMPLE DISTRIBUTION OF SLOPE FOR BIVARIATE NORMAL POPULATIONS.
...ON AND MEAN VALUES OF Y. BASED SAMPLE SIZES. FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF
-STIMATE BASED ON A CORRELATION OF 0.7

SAMPLE SIZE

		N=5			N=13			N=37		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	0.0	-0.0060	-0.0064	0.0	0.0200	0.0209	0.0	0.0003	-0.0005
	VAR	0.5774	0.5786	0.6961	0.3015	0.3017	0.3215	0.1644	0.1638	0.1678
FN	SKEW	0.0	0.0	-0.2133	0.0	0.0	-0.0412	0.0	0.0	0.0124
	KURT	0.0	0.0	2.6233	0.0	0.0	0.3137	0.0	0.0	0.1732
...OR=	0									
	MEAN	0.0	0.0102	0.0155	0.0	-0.0060	-0.0058	0.0	-0.0003	-0.0008
	VAR	0.5774	0.5336	0.4879	0.3015	0.3306	0.3169	0.1644	0.1694	0.1720
FN	SKEW	0.0	0.0	0.0024	0.0	0.0	-0.0098	0.0	0.0	-0.0939
	KURT	0.0	0.0	0.1397	0.0	0.0	-0.0495	0.0	0.0	0.1181
	MEAN	0.0	-0.0039	-0.0136	0.0	0.0183	0.0188	0.0	-0.0011	-0.0012
	VAR	0.5774	0.5452	0.6058	0.3015	0.2865	0.3095	0.1644	0.1556	0.1507
FN	SKEW	0.0	0.0	-0.4989	0.0	0.0	-0.1023	0.0	0.0	-0.0077
	KURT	0.0	0.0	0.1810	0.0	0.0	0.0684	0.0	0.0	0.0983
...OR=	33									
	MEAN	0.0	0.0081	0.0076	0.0	-0.0038	-0.0091	0.0	0.0007	0.0012
	VAR	0.5774	0.5231	0.4988	0.3015	0.3045	0.3071	0.1644	0.1478	0.1498
FN	SKEW	0.0	0.0	-0.0868	0.0	0.0	-0.1169	0.0	0.0	0.1257
	KURT	0.0	0.0	0.3662	0.0	0.0	0.0635	0.0	0.0	0.2442
	MEAN	0.0	-0.0224	-0.0146	0.0	0.0067	0.0081	0.0	-0.0028	-0.0029
	VAR	0.5774	0.4767	0.6248	0.3015	0.2521	0.2541	0.1644	0.1358	0.1344
FN	SKEW	0.0	0.0	2.6930	0.0	0.0	0.0894	0.0	0.0	0.0736
	KURT	0.0	0.0	45.2763	0.0	0.0	0.9852	0.0	0.0	0.2261
...OR=	67									
	MEAN	0.0	0.0125	0.0187	0.0	0.0041	0.0048	0.0	-0.0048	-0.0051
	VAR	0.5774	0.4480	0.4929	0.3015	0.2524	0.2659	0.1644	0.1104	0.1149
FN	SKEW	0.0	0.0	0.4654	0.0	0.0	0.1317	0.0	0.0	0.0091
	KURT	0.0	0.0	4.3253	0.0	0.0	0.5754	0.0	0.0	0.3672
	MEAN	0.0	-0.0135	-0.0178	0.0	0.0043	0.0035	0.0	0.0016	0.0012
	VAR	0.5774	0.4049	0.5008	0.3015	0.2118	0.2212	0.1644	0.1160	0.1137
FN	SKEW	0.0	0.0	-2.3842	0.0	0.0	0.0019	0.0	0.0	0.0508
	KURT	0.0	0.0	41.4469	0.0	0.0	0.4162	0.0	0.0	0.2220
...OR=	100									
	MEAN	0.0	-0.0065	0.0020	0.0	0.0038	0.0009	0.0	0.0016	0.0020
	VAR	0.5774	0.4000	0.5361	0.3015	0.2021	0.2100	0.1644	0.0839	0.0913
FN	SKEW	0.0	0.0	0.1452	0.0	0.0	-0.0433	0.0	0.0	-0.0634
	KURT	0.0	0.0	50.5256	0.0	0.0	1.3571	0.0	0.0	0.7975

TABLE 3 STATISTICAL CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VARIABLES, FOUR SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF EXPECTED ESTIMATE BASED ON A CORRELATION OF 0.30

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	0.3000	0.2840	0.3180	0.3000	0.2982	0.3091	0.3000	0.2982	0.3020
	VAR	0.5508	0.5595	0.5301	0.2876	0.2900	0.3042	0.1568	0.1573	0.1535
RN	SKEW	0.0	0.0	0.0125	0.0	0.0	-0.0450	0.0	0.0	-0.0779
	KURT	0.0	0.0	5.6637	0.0	0.0	0.8004	0.0	0.0	0.3244
ERROR= 0										
	MEAN	0.3000	0.2649	0.2892	0.3000	0.2829	0.2944	0.3000	0.2933	0.2972
	VAR	0.5508	0.5165	0.4633	0.2876	0.3134	0.3078	0.1568	0.1622	0.1589
FN	SKEW	0.0	0.0	0.0135	0.0	0.0	0.0568	0.0	0.0	0.0607
	KURT	0.0	0.0	-0.0198	0.0	0.0	0.1913	0.0	0.0	0.1581
	MEAN	0.3000	0.2396	0.2741	0.3000	0.2605	0.2707	0.3000	0.2665	0.2704
	VAR	0.5508	0.5333	0.6373	0.2876	0.2768	0.2881	0.1568	0.1496	0.1532
RN	SKEW	0.0	0.0	0.8701	0.0	0.0	-0.0357	0.0	0.0	0.0753
	KURT	0.0	0.0	13.0967	0.0	0.0	0.8162	0.0	0.0	-0.0193
ERROR= 33										
	MEAN	0.3000	0.2200	0.2705	0.3000	0.2523	0.2663	0.3000	0.2195	0.2257
	VAR	0.5508	0.4939	0.4701	0.2876	0.2962	0.2965	0.1568	0.1426	0.1473
FN	SKEW	0.0	0.0	0.0663	0.0	0.0	0.1018	0.0	0.0	0.0749
	KURT	0.0	0.0	0.0051	0.0	0.0	0.3286	0.0	0.0	0.2692
	MEAN	0.3000	0.1747	0.2054	0.3000	0.1999	0.2032	0.3000	0.2085	0.2108
	VAR	0.5508	0.4764	0.5695	0.2876	0.2451	0.2528	0.1568	0.1323	0.1321
RN	SKEW	0.0	0.0	-0.1059	0.0	0.0	-0.0482	0.0	0.0	0.0286
	KURT	0.0	0.0	8.2305	0.0	0.0	0.5690	0.0	0.0	0.2315
ERROR= 67										
	MEAN	0.3000	0.1814	0.2246	0.3000	0.1752	0.1862	0.3000	0.1258	0.1308
	VAR	0.5508	0.4418	0.4765	0.2876	0.2430	0.2560	0.1568	0.1078	0.1135
FN	SKEW	0.0	0.0	0.1160	0.0	0.0	0.0353	0.0	0.0	0.2316
	KURT	0.0	0.0	2.1005	0.0	0.0	0.7815	0.0	0.0	0.3991
	MEAN	0.3000	0.1231	0.1435	0.3000	0.1422	0.1484	0.3000	0.1495	0.1516
	VAR	0.5508	0.3875	0.4608	0.2876	0.2077	0.2154	0.1568	0.1147	0.1173
RN	SKEW	0.0	0.0	0.1214	0.0	0.0	-0.0557	0.0	0.0	0.0460
	KURT	0.0	0.0	3.7064	0.0	0.0	0.2637	0.0	0.0	0.3506
ERROR=100										
	MEAN	0.3000	0.1244	0.1470	0.3000	0.1124	0.1215	0.3000	0.0737	0.0776
	VAR	0.5508	0.4155	0.5029	0.2876	0.2016	0.2125	0.1568	0.0330	0.0925
FN	SKEW	0.0	0.0	-1.6579	0.0	0.0	0.1604	0.0	0.0	0.2056
	KURT	0.0	0.0	24.4725	0.0	0.0	0.5892	0.0	0.0	0.8018

TABLE 4. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR BIVARIATE NORMAL POPULATIONS, SAMPLING AT FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
	MEAN	0.6000	0.5454	0.6033	0.6000	0.5845	0.6023	0.6000	0.5958	0.6012
	VAR	0.4619	0.4494	0.5815	0.2412	0.2475	0.2525	0.1315	0.1331	0.1335
RN	SKEW	0.0	0.0	0.5441	0.0	0.0	0.0189	0.0	0.0	-0.1021
	KURT	0.0	0.0	10.1311	0.0	0.0	0.6620	0.0	0.0	0.1191
ERROR= 0										
	MEAN	0.6000	0.5735	0.6053	0.6000	0.5774	0.5935	0.6000	0.5934	0.5972
	VAR	0.4619	0.4620	0.3905	0.2412	0.2672	0.2580	0.1315	0.1362	0.1374
RN	SKEW	0.0	0.0	0.0312	0.0	0.0	0.0156	0.0	0.0	0.0376
	KURT	0.0	0.0	-0.1357	0.0	0.0	-0.1098	0.0	0.0	-0.1348
	MEAN	0.6000	0.4900	0.5312	0.6000	0.5320	0.5486	0.6000	0.5371	0.5423
	VAR	0.4619	0.4657	0.5250	0.2412	0.2407	0.2483	0.1315	0.1291	0.1331
RN	SKEW	0.0	0.0	-0.2511	0.0	0.0	0.0179	0.0	0.0	0.0344
	KURT	0.0	0.0	4.2112	0.0	0.0	0.6477	0.0	0.0	0.1587
ERROR= 33										
	MEAN	0.6000	0.5148	0.5561	0.6000	0.4951	0.5159	0.6000	0.4465	0.4563
	VAR	0.4619	0.4248	0.3885	0.2412	0.2536	0.2584	0.1315	0.1249	0.1339
RN	SKEW	0.0	0.0	0.1883	0.0	0.0	0.2107	0.0	0.0	0.2898
	KURT	0.0	0.0	3.1651	0.0	0.0	0.1193	0.0	0.0	0.4465
	MEAN	0.6000	0.3772	0.4200	0.6000	0.3913	0.4055	0.6000	0.4073	0.4112
	VAR	0.4619	0.4239	0.5052	0.2412	0.2239	0.2296	0.1315	0.1184	0.1191
RN	SKEW	0.0	0.0	0.2609	0.0	0.0	0.0262	0.0	0.0	0.0002
	KURT	0.0	0.0	4.1073	0.0	0.0	0.5560	0.0	0.0	0.0208
ERROR= 67										
	MEAN	0.6000	0.3906	0.4448	0.6000	0.3351	0.3551	0.6000	0.2534	0.2634
	VAR	0.4619	0.3967	0.4138	0.2412	0.2214	0.2291	0.1315	0.1315	0.1186
RN	SKEW	0.0	0.0	0.5304	0.0	0.0	0.2973	0.0	0.0	0.2715
	KURT	0.0	0.0	1.7340	0.0	0.0	0.4058	0.0	0.0	0.5836
	MEAN	0.6000	0.2767	0.3096	0.6000	0.2838	0.2999	0.6000	0.2984	0.3012
	VAR	0.4619	0.3796	0.4614	0.2412	0.1969	0.1992	0.1315	0.1063	0.1062
RN	SKEW	0.0	0.0	-2.0424	0.0	0.0	0.0913	0.0	0.0	-0.0654
	KURT	0.0	0.0	34.8229	0.0	0.0	0.0938	0.0	0.0	0.0550
ERROR=100										
	MEAN	0.6000	0.2775	0.3215	0.6000	0.2139	0.2259	0.6000	0.1449	0.1514
	VAR	0.4619	0.3537	0.4143	0.2412	0.1855	0.1973	0.1315	0.0795	0.0979
RN	SKEW	0.0	0.0	0.2614	0.0	0.0	0.1810	0.0	0.0	0.2764
	KURT	0.0	0.0	4.5623	0.0	0.0	1.0881	0.0	0.0	0.6212

TABLE 5. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR BIVARIATE NORMAL POPULATIONS, [illegible] VALUES OF ρ, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF .900

SAMPLE SIZE

		N=5			N=15			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	0.9000	0.8700	0.9025	0.9000	0.8928	0.9009	0.9000	0.8971	0.8993
	VAR	0.2517	0.2820	0.2934	0.1314	0.1357	0.1381	0.0717	0.0722	0.0727
FN	SKEW	0.0	0.0	-0.0195	0.0	0.0	-0.0601	0.0	0.0	-0.0125
	KURT	0.0	0.0	2.2273	0.0	0.0	0.4540	0.0	0.0	0.2267
ERROR= 0										
	MEAN	0.9000	0.8946	0.9064	0.9000	0.8987	0.9004	0.9000	0.9000	0.9005
	VAR	0.2517	0.2249	0.2198	0.1314	0.1427	0.1385	0.0717	0.0736	0.0720
FN	SKEW	0.0	0.0	0.0591	0.0	0.0	0.0406	0.0	0.0	-0.0775
	KURT	0.0	0.0	0.0151	0.0	0.0	-0.0789	0.0	0.0	-0.0921
	MEAN	0.9000	0.8602	0.8900	0.9000	0.7996	0.8098	0.9000	0.8092	0.8124
	VAR	0.2517	0.2905	0.2994	0.1314	0.1543	0.1553	0.0717	0.0815	0.0823
FN	SKEW	0.0	0.0	-0.3130	0.0	0.0	0.0122	0.0	0.0	0.1035
	KURT	0.0	0.0	3.6303	0.0	0.0	0.4552	0.0	0.0	0.2101
ERROR= 33										
	MEAN	0.9000	0.8056	0.8318	0.9000	0.7693	0.7834	0.9000	0.6782	0.6894
	VAR	0.2517	0.2551	0.2622	0.1314	0.1444	0.1711	0.0717	0.0912	0.1196
FN	SKEW	0.0	0.0	0.6013	0.0	0.0	0.4664	0.0	0.0	0.2293
	KURT	0.0	0.0	3.6313	0.0	0.0	0.6940	0.0	0.0	0.1888
	MEAN	0.9000	0.5312	0.6243	0.9000	0.6068	0.6180	0.9000	0.6146	0.6184
	VAR	0.2517	0.3435	0.3423	0.1314	0.1712	0.1706	0.0717	0.0915	0.0894
FN	SKEW	0.0	0.0	0.2913	0.0	0.0	0.0351	0.0	0.0	-0.0328
	KURT	0.0	0.0	3.6282	0.0	0.0	0.5498	0.0	0.0	0.0040
ERROR= 67										
	MEAN	0.9000	0.5216	0.6788	0.9000	0.5121	0.5294	0.9000	0.3752	0.3879
	VAR	0.2517	0.3086	0.3387	0.1314	0.1751	0.1747	0.0717	0.0375	0.1233
FN	SKEW	0.0	0.0	0.8725	0.0	0.0	0.4596	0.0	0.0	0.0938
	KURT	0.0	0.0	7.2520	0.0	0.0	1.0038	0.0	0.0	0.0721
	MEAN	0.9000	0.4107	0.4474	0.9000	0.4379	0.4498	0.9000	0.4454	0.4491
	VAR	0.2517	0.3353	0.3993	0.1314	0.1661	0.1734	0.0717	0.0903	0.0914
FN	SKEW	0.0	0.0	-0.2573	0.0	0.0	0.0589	0.0	0.0	0.0293
	KURT	0.0	0.0	3.6377	0.0	0.0	0.3697	0.0	0.0	0.3384
ERROR=100										
	MEAN	0.9000	0.4000	0.4050	0.9000	0.3278	0.3407	0.9000	0.2221	0.2314
	VAR	0.2517	0.3372	0.3405	0.1314	0.1586	0.1676	0.0717	0.0740	0.1081
FN	SKEW	0.0	0.0	0.1198	0.0	0.0	0.0811	0.0	0.0	-0.0476
	KURT	0.0	0.0	11.7665	0.0	0.0	1.0218	0.0	0.0	0.2499

TABLE 3. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY DISTRIBUTED WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X , RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

SAMPLE SIZE

		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	0.0	-0.0010	0.0025	0.0	-0.0002	0.0011	0.0	-0.0026	-0.0032
	VAR	0.5774	0.5563	0.6306	0.3015	0.2979	0.3120	0.1644	0.1642	0.1640
RR	SKEW	0.0	0.0	0.2345	0.0	0.0	0.0381	0.0	0.0	-0.0461
	KURT	0.0	0.0	5.2497	0.0	0.0	0.4799	0.0	0.0	0.0765
ERROR= 0										
	MEAN	0.0	-0.0163	-0.0235	0.0	0.0057	0.0057	0.0	-0.0025	-0.0019
	VAR	0.5774	0.5435	0.4997	0.3015	0.2843	0.2749	0.1644	0.1616	0.1583
RR	SKEW	0.0	0.0	-0.0913	0.0	0.0	-0.0518	0.0	0.0	0.0256
	KURT	0.0	0.0	0.1162	0.0	0.0	0.0803	0.0	0.0	0.0988
	MEAN	0.0	0.0133	0.0139	0.0	-0.0023	-0.0016	0.0	0.0014	0.0005
	VAR	0.5774	0.5379	0.6456	0.3015	0.2840	0.2869	0.1644	0.1556	0.1611
RR	SKEW	0.0	0.0	-0.0666	0.0	0.0	-0.0410	0.0	0.0	-0.0656
	KURT	0.0	0.0	4.7423	0.0	0.0	0.2406	0.0	0.0	-0.1962
ERROR= 33										
	MEAN	0.0	-0.0047	-0.0047	0.0	-0.0045	-0.0029	0.0	0.0021	0.0025
	VAR	0.5774	0.5185	0.5056	0.3015	0.2723	0.2629	0.1644	0.1469	0.1475
RR	SKEW	0.0	0.0	0.0785	0.0	0.0	0.0135	0.0	0.0	0.0498
	KURT	0.0	0.0	0.5599	0.0	0.0	0.0063	0.0	0.0	0.1323
	MEAN	0.0	-0.0045	-0.0053	0.0	0.0010	-0.0008	0.0	0.0012	0.0010
	VAR	0.5774	0.4778	0.5492	0.3015	0.2533	0.2616	0.1644	0.1363	0.1396
RR	SKEW	0.0	0.0	0.0545	0.0	0.0	-0.0435	0.0	0.0	0.0479
	KURT	0.0	0.0	3.4114	0.0	0.0	0.5606	0.0	0.0	0.1637
ERROR= 67										
	MEAN	0.0	0.0025	-0.0003	0.0	0.0030	0.0019	0.0	0.0019	0.0022
	VAR	0.5774	0.4646	0.5014	0.3015	0.2436	0.2495	0.1644	0.1199	0.1230
RR	SKEW	0.0	0.0	0.1214	0.0	0.0	-0.0014	0.0	0.0	-0.0366
	KURT	0.0	0.0	3.1687	0.0	0.0	0.3886	0.0	0.0	0.2597
	MEAN	0.0	0.0068	0.0151	0.0	-0.0072	-0.0078	0.0	0.0025	0.0023
	VAR	0.5774	0.4071	0.4837	0.3015	0.2130	0.2233	0.1644	0.1159	0.1163
RR	SKEW	0.0	0.0	0.1121	0.0	0.0	0.0746	0.0	0.0	0.0421
	KURT	0.0	0.0	7.0369	0.0	0.0	0.7579	0.0	0.0	-0.0377
ERROR=100										
	MEAN	0.0	0.0068	0.0019	0.0	0.0004	-0.0009	0.0	-0.0016	-0.0025
	VAR	0.5774	0.4033	0.4533	0.3015	0.2038	0.2155	0.1644	0.0959	0.1034
RR	SKEW	0.0	0.0	-0.4712	0.0	0.0	-0.1418	0.0	0.0	-0.0269
	KURT	0.0	0.0	4.1137	0.0	0.0	0.5092	0.0	0.0	0.0924

TABLE 7 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X , RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.30

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	0.3000	0.2679	0.2995	0.3000	0.3024	0.3137	0.3000	0.2978	0.3007
	VAR	0.5508	0.5469	0.6007	0.2876	0.2821	0.2853	0.1568	0.1565	0.1558
RR	SKEW	0.0	0.0	0.1613	0.0	0.0	-0.1122	0.0	0.0	-0.0125
	KURT	0.0	0.0	4.3044	0.0	0.0	0.5110	0.0	0.0	0.1141
ERROR= 0										
	MEAN	0.3000	0.2742	0.3068	0.3000	0.2939	0.3040	0.3000	0.3010	0.3026
	VAR	0.5508	0.5161	0.4753	0.2876	0.2733	0.2639	0.1568	0.1680	0.1523
FR	SKEW	0.0	0.0	0.0520	0.0	0.0	0.1444	0.0	0.0	0.0222
	KURT	0.0	0.0	-0.0315	0.0	0.0	0.0490	0.0	0.0	-0.1656
	MEAN	0.3000	0.2216	0.2514	0.3000	0.2587	0.2697	0.3000	0.2671	0.2718
	VAR	0.5508	0.5068	0.6054	0.2876	0.2729	0.2751	0.1568	0.1501	0.1505
RR	SKEW	0.0	0.0	-0.2467	0.0	0.0	0.0386	0.0	0.0	0.0913
	KURT	0.0	0.0	10.3975	0.0	0.0	0.3247	0.0	0.0	0.0885
ERROR= 33										
	MEAN	0.3000	0.2461	0.2858	0.3000	0.2614	0.2737	0.3000	0.2551	0.2599
	VAR	0.5508	0.5020	0.4768	0.2876	0.2613	0.2641	0.1568	0.1544	0.1507
FR	SKEW	0.0	0.0	0.2139	0.0	0.0	0.0898	0.0	0.0	0.0347
	KURT	0.0	0.0	0.4467	0.0	0.0	0.2244	0.0	0.0	0.1770
	MEAN	0.3000	0.1752	0.2059	0.3000	0.2038	0.2145	0.3000	0.2070	0.2107
	VAR	0.5508	0.4652	0.5290	0.2876	0.2409	0.2519	0.1568	0.1316	0.1350
RR	SKEW	0.0	0.0	0.2369	0.0	0.0	0.1337	0.0	0.0	-0.0186
	KURT	0.0	0.0	3.4234	0.0	0.0	0.7664	0.0	0.0	0.1101
ERROR= 67										
	MEAN	0.3000	0.2375	0.2469	0.3000	0.2125	0.2253	0.3000	0.1638	0.1683
	VAR	0.5508	0.4492	0.4574	0.2876	0.2341	0.2417	0.1568	0.1270	0.1300
FR	SKEW	0.0	0.0	0.2227	0.0	0.0	0.1501	0.0	0.0	0.1050
	KURT	0.0	0.0	0.8834	0.0	0.0	0.2096	0.0	0.0	0.3206
	MEAN	0.3000	0.1408	0.1694	0.3000	0.1497	0.1560	0.3000	0.1454	0.1472
	VAR	0.5508	0.3980	0.4774	0.2876	0.2105	0.2146	0.1568	0.1137	0.1121
RR	SKEW	0.0	0.0	0.4942	0.0	0.0	0.0030	0.0	0.0	0.0271
	KURT	0.0	0.0	5.6341	0.0	0.0	0.4666	0.0	0.0	-0.0637
ERROR=100										
	MEAN	0.3000	0.1537	0.1682	0.3000	0.1442	0.1528	0.3000	0.1021	0.1043
	VAR	0.5508	0.4012	0.4825	0.2876	0.2021	0.2036	0.1568	0.0956	0.0999
FR	SKEW	0.0	0.0	0.6694	0.0	0.0	0.1010	0.0	0.0	0.1968
	KURT	0.0	0.0	0.1417	0.0	0.0	0.5023	0.0	0.0	0.5524

TABLE 8 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X , RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, EQUI-PRODUCTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

		SAMPLE SIZE N=5			N=13			N=39		
		EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
	MEAN	0.6000	0.5456	0.5395	0.6000	0.5706	0.5933	0.6000	0.5937	0.5983
	VAR	0.4619	0.4714	0.5125	0.2412	0.2415	0.2395	0.1315	0.1312	0.1336
RR	SKEW	0.0	0.0	-0.5311	0.0	0.0	-0.0133	0.0	0.0	-0.1183
	KURT	0.0	0.0	11.1175	0.0	0.0	0.1800	0.0	0.0	0.1394
ERROR= 0										
	MEAN	0.6000	0.5515	0.5925	0.6000	0.5812	0.5926	0.6000	0.6010	0.6041
	VAR	0.4619	0.4668	0.4111	0.2412	0.2276	0.2246	0.1315	0.1291	0.1273
FR	SKEW	0.0	0.0	0.0643	0.0	0.0	-0.0133	0.0	0.0	0.0639
	KURT	0.0	0.0	0.0043	0.0	0.0	0.2756	0.0	0.0	0.0339
	MEAN	0.6000	0.4969	0.5397	0.6000	0.5372	0.5517	0.6000	0.5447	0.5495
	VAR	0.4619	0.4571	0.5385	0.2412	0.2340	0.2360	0.1315	0.1282	0.1269
RR	SKEW	0.0	0.0	-3.3334	0.0	0.0	0.1598	0.0	0.0	0.0460
	KURT	0.0	0.0	66.0961	0.0	0.0	0.7412	0.0	0.0	0.1676
ERROR= 33										
	MEAN	0.6000	0.5239	0.5784	0.6000	0.5380	0.5512	0.6000	0.4989	0.5061
	VAR	0.4619	0.4738	0.4112	0.2412	0.2229	0.2192	0.1315	0.1237	0.1307
FR	SKEW	0.0	0.0	0.1275	0.0	0.0	0.1311	0.0	0.0	0.3083
	KURT	0.0	0.0	0.2329	0.0	0.0	0.1301	0.0	0.0	0.2881
	MEAN	0.6000	0.3911	0.4363	0.6000	0.4063	0.4239	0.6000	0.4153	0.4199
	VAR	0.4619	0.4119	0.4566	0.2412	0.2171	0.2186	0.1315	0.1185	0.1175
RR	SKEW	0.0	0.0	0.5362	0.0	0.0	0.0596	0.0	0.0	0.1572
	KURT	0.0	0.0	5.0615	0.0	0.0	0.8023	0.0	0.0	0.2314
ERROR= 67										
	MEAN	0.6000	0.4055	0.4602	0.6000	0.4294	0.4446	0.6000	0.3269	0.3332
	VAR	0.4619	0.4072	0.4222	0.2412	0.2095	0.2025	0.1315	0.1090	0.1123
FR	SKEW	0.0	0.0	0.5914	0.0	0.0	0.2562	0.0	0.0	0.1212
	KURT	0.0	0.0	2.9812	0.0	0.0	0.3852	0.0	0.0	0.4418
	MEAN	0.6000	0.2948	0.3295	0.6000	0.2975	0.3120	0.6000	0.2953	0.2988
	VAR	0.4619	0.3723	0.4701	0.2412	0.1929	0.1973	0.1315	0.1055	0.1033
RR	SKEW	0.0	0.0	-3.7075	0.0	0.0	0.1675	0.0	0.0	-0.0515
	KURT	0.0	0.0	81.2427	0.0	0.0	0.5117	0.0	0.0	0.1173
ERROR=100										
	MEAN	0.6000	0.2934	0.3346	0.6000	0.3076	0.3188	0.6000	0.2101	0.2137
	VAR	0.4619	0.3699	0.3863	0.2412	0.1834	0.1802	0.1315	0.0931	0.0983
FR	SKEW	0.0	0.0	0.5333	0.0	0.0	0.2339	0.0	0.0	-0.0175
	KURT	0.0	0.0	5.5214	0.0	0.0	0.5044	0.0	0.0	0.3156

TABLE 2. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X , RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF .33

SAMPLE SIZE

		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	0.9000	0.8718	0.8954	0.9000	0.8812	0.8956	0.9000	0.8973	0.8985
	VAR	0.2517	0.2649	0.2794	0.1314	0.1323	0.1310	0.0717	0.0717	0.0729
RR	SKEW	0.0	0.0	0.2711	0.0	0.0	-0.0472	0.0	0.0	-0.0852
	KURT	0.0	0.0	12.2902	0.0	0.0	0.4338	0.0	0.0	0.0304
ERR= 0										
	MEAN	0.9000	0.9020	0.9062	0.9000	0.8998	0.9009	0.9000	0.8976	0.8980
	VAR	0.2517	0.2272	0.2181	0.1314	0.1228	0.1218	0.0717	0.0701	0.0693
FR	SKEW	0.0	0.0	0.0353	0.0	0.0	-0.0216	0.0	0.0	-0.0113
	KURT	0.0	0.0	0.0151	0.0	0.0	-0.0069	0.0	0.0	-0.0317
	MEAN	0.9000	0.7345	0.8177	0.9000	0.8078	0.8160	0.9000	0.8113	0.8137
	VAR	0.2517	0.3007	0.3227	0.1314	0.1474	0.1450	0.0717	0.0809	0.0799
RR	SKEW	0.0	0.0	-0.0949	0.0	0.0	0.1183	0.0	0.0	0.0654
	KURT	0.0	0.0	5.2204	0.0	0.0	0.4174	0.0	0.0	-0.0315
ERR= 33										
	MEAN	0.9000	0.8243	0.8490	0.9000	0.8134	0.8264	0.9000	0.7545	0.7618
	VAR	0.2517	0.2597	0.2596	0.1314	0.1337	0.1368	0.0717	0.0846	0.0990
FR	SKEW	0.0	0.0	0.6164	0.0	0.0	0.1663	0.0	0.0	0.4896
	KURT	0.0	0.0	1.4000	0.0	0.0	0.2196	0.0	0.0	0.4881
	MEAN	0.9000	0.6044	0.6392	0.9000	0.6177	0.6303	0.9000	0.6191	0.6229
	VAR	0.2517	0.3292	0.3911	0.1314	0.1652	0.1572	0.0717	0.0907	0.0860
RR	SKEW	0.0	0.0	-1.5498	0.0	0.0	0.3015	0.0	0.0	0.2088
	KURT	0.0	0.0	23.3747	0.0	0.0	0.7258	0.0	0.0	0.1993
ERR= 67										
	MEAN	0.9000	0.6592	0.7060	0.9000	0.6507	0.6641	0.9000	0.4937	0.5013
	VAR	0.2517	0.3054	0.3090	0.1314	0.1611	0.1456	0.0717	0.0902	0.0985
FR	SKEW	0.0	0.0	1.0129	0.0	0.0	0.6010	0.0	0.0	0.2160
	KURT	0.0	0.0	7.2398	0.0	0.0	0.8191	0.0	0.0	0.4362
	MEAN	0.9000	0.4363	0.4760	0.9000	0.4516	0.4623	0.9000	0.4507	0.4538
	VAR	0.2517	0.3255	0.3761	0.1314	0.1657	0.1559	0.0717	0.0900	0.0806
RR	SKEW	0.0	0.0	1.1926	0.0	0.0	0.1164	0.0	0.0	0.0131
	KURT	0.0	0.0	12.2619	0.0	0.0	0.8125	0.0	0.0	0.2449
ERR=100										
	MEAN	0.9000	0.4632	0.4931	0.9000	0.4742	0.4842	0.9000	0.3141	0.3174
	VAR	0.2517	0.3269	0.3497	0.1314	0.1625	0.1387	0.0717	0.0825	0.0957
FR	SKEW	0.0	0.0	0.1520	0.0	0.0	0.3364	0.0	0.0	-0.2581
	KURT	0.0	0.0	8.1909	0.0	0.0	0.7289	0.0	0.0	0.9491

TABLE 13. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTIONS OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	50.0000	50.4481	49.9050	50.0000	48.8994	48.9327	50.0000	50.0618	49.8521
	VAR	20.1556	20.1261	21.9487	10.8333	10.8300	11.3960	5.9254	5.9003	6.0610
RN	SKEW	0.0	0.0	-0.1732	0.0	0.0	0.0570	0.0	0.0	-0.0732
	KURT	0.0	0.0	1.5999	0.0	0.0	0.0984	0.0	0.0	-0.0341
ERROR= 0										
	MEAN	50.0000	49.1932	49.1635	50.0000	50.2839	50.2492	50.0000	50.0511	50.0422
	VAR	20.1556	18.2015	17.9099	10.8333	11.8309	11.3150	5.9254	6.0979	6.0725
FN	SKEW	0.0	0.0	0.0951	0.0	0.0	-0.0122	0.0	0.0	0.0665
	KURT	0.0	0.0	-0.0651	0.0	0.0	0.2366	0.0	0.0	0.0941
	MEAN	50.0000	50.6097	50.1752	50.0000	49.0038	49.0365	50.0000	50.0987	50.0813
	VAR	20.1556	19.0422	19.9734	10.8333	10.3103	11.0422	5.9254	5.6219	5.6414
RN	SKEW	0.0	0.0	-0.2951	0.0	0.0	0.1118	0.0	0.0	-0.0375
	KURT	0.0	0.0	1.7296	0.0	0.0	0.3197	0.0	0.0	0.1415
ERROR= 33										
	MEAN	50.0000	49.4599	49.5221	50.0000	50.4611	50.5480	50.0000	49.9445	50.0436
	VAR	20.1556	18.2755	17.1612	10.8333	10.9407	10.6450	5.9254	5.3554	5.6605
FN	SKEW	0.0	0.0	-0.0513	0.0	0.0	0.2051	0.0	0.0	-0.0600
	KURT	0.0	0.0	0.6303	0.0	0.0	0.3556	0.0	0.0	-0.0304
	MEAN	50.0000	50.8335	50.9179	50.0000	49.5761	49.5606	50.0000	50.1304	50.1677
	VAR	20.1556	16.8057	17.6979	10.8333	9.1170	9.3149	5.9254	4.9397	4.8414
RN	SKEW	0.0	0.0	-0.1336	0.0	0.0	-0.0755	0.0	0.0	-0.1267
	KURT	0.0	0.0	1.3360	0.0	0.0	0.3904	0.0	0.0	0.1380
ERROR= 67										
	MEAN	50.0000	48.9814	49.3670	50.0000	49.7265	49.8536	50.0000	50.2435	50.2199
	VAR	20.1556	15.7496	15.8407	10.8333	9.1253	9.8351	5.9254	4.0666	5.6826
FN	SKEW	0.0	0.0	0.1752	0.0	0.0	0.0372	0.0	0.0	0.0467
	KURT	0.0	0.0	0.2796	0.0	0.0	0.2615	0.0	0.0	0.1521
	MEAN	50.0000	50.8533	50.8973	50.0000	49.6951	49.9107	50.0000	49.9449	49.9664
	VAR	20.1556	14.3198	16.1592	10.8333	7.7554	8.2863	5.9254	4.2514	4.4828
RN	SKEW	0.0	0.0	0.2547	0.0	0.0	-0.0107	0.0	0.0	-0.1001
	KURT	0.0	0.0	1.5536	0.0	0.0	0.0497	0.0	0.0	0.1677
ERROR=100										
	MEAN	50.0000	50.1312	50.3663	50.0000	49.9073	49.8437	50.0000	49.9309	49.8047
	VAR	20.1556	13.3911	15.5647	10.8333	7.4078	8.1050	5.9254	3.1750	6.7315
FN	SKEW	0.0	0.0	0.3927	0.0	0.0	0.0293	0.0	0.0	-0.0402
	KURT	0.0	0.0	0.5033	0.0	0.0	0.3100	0.0	0.0	-0.0242

TABLE II SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.80

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	35.0000	34.0461	33.7203	35.0000	34.5459	34.4743	35.0000	34.8728	34.9663
	VAR	19.2273	19.4547	20.3450	10.3343	10.4131	10.5761	5.6525	5.6758	5.8795
RN	SKEW	0.0	0.0	-0.0227	0.0	0.0	-0.1135	0.0	0.0	0.0754
	KURT	0.0	0.0	1.2738	0.0	0.0	0.2979	0.0	0.0	-0.0541
ERROR= 0										
	MEAN	35.0000	35.4477	35.5707	35.0000	35.3324	35.2576	35.0000	35.1564	35.1352
	VAR	19.2273	18.0299	16.5833	10.3343	11.2150	10.9759	5.6525	5.8385	5.6478
RN	SKEW	0.0	0.0	-0.0405	0.0	0.0	0.0192	0.0	0.0	0.0132
	KURT	0.0	0.0	-0.1218	0.0	0.0	0.1704	0.0	0.0	-0.0265
	MEAN	35.0000	36.2631	36.8658	35.0000	36.4326	36.6256	35.0000	36.4364	36.5421
	VAR	19.2273	18.6408	18.4969	10.3343	9.9774	9.8226	5.6525	5.4031	5.6687
RN	SKEW	0.0	0.0	0.1479	0.0	0.0	0.1009	0.0	0.0	-0.1328
	KURT	0.0	0.0	0.9250	0.0	0.0	0.2977	0.0	0.0	-0.0320
ERROR= 33										
	MEAN	35.0000	36.3917	36.8996	35.0000	36.7585	36.8648	35.0000	38.6874	38.9555
	VAR	19.2273	17.2573	16.3065	10.3343	10.6210	10.7272	5.6525	5.1672	5.6700
RN	SKEW	0.0	0.0	0.0599	0.0	0.0	-0.0203	0.0	0.0	-0.0151
	KURT	0.0	0.0	-0.0874	0.0	0.0	0.0467	0.0	0.0	0.0436
	MEAN	35.0000	39.4565	39.9268	35.0000	39.6128	39.6266	35.0000	39.4946	39.4931
	VAR	19.2273	16.6960	17.1802	10.3343	8.3824	9.1452	5.6525	4.8081	4.9300
RN	SKEW	0.0	0.0	0.0142	0.0	0.0	-0.0443	0.0	0.0	-0.1098
	KURT	0.0	0.0	1.3557	0.0	0.0	0.1795	0.0	0.0	-0.1008
ERROR= 67										
	MEAN	35.0000	38.8104	39.4383	35.0000	40.6405	41.0824	35.0000	43.4441	43.6814
	VAR	19.2273	15.5644	15.9439	10.3343	8.8146	9.1560	5.6525	3.9782	5.7022
RN	SKEW	0.0	0.0	-0.4383	0.0	0.0	-0.0093	0.0	0.0	-0.0874
	KURT	0.0	0.0	0.8924	0.0	0.0	0.1707	0.0	0.0	-0.0390
	MEAN	35.0000	43.3368	42.8449	35.0000	42.6179	42.6512	35.0000	42.3750	42.4181
	VAR	19.2273	13.7378	13.7185	10.3343	7.5974	8.4607	5.6525	4.2082	4.6399
RN	SKEW	0.0	0.0	0.0981	0.0	0.0	0.1301	0.0	0.0	-0.0593
	KURT	0.0	0.0	1.5126	0.0	0.0	0.1241	0.0	0.0	-0.0013
ERROR=100										
	MEAN	35.0000	42.7631	42.1953	35.0000	43.9850	43.9987	35.0000	46.1013	46.2043
	VAR	19.2273	13.6337	15.6959	10.3343	7.3820	8.5186	5.6525	3.1415	6.7214
RN	SKEW	0.0	0.0	-0.1241	0.0	0.0	-0.0648	0.0	0.0	0.0453
	KURT	0.0	0.0	0.3189	0.0	0.0	0.3419	0.0	0.0	0.0155

TABLE 12. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR IN ESTIMATE ASSUMED & CORRELATION OF 0.60

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	20.0000	20.0034	19.8697	20.0000	19.8367	19.9969	20.0000	19.9733	19.9448
	VAR	16.1245	17.0025	17.0883	8.6667	8.8973	8.8739	4.7403	4.7967	4.7978
RN	SKEW	0.0	0.0	-0.2179	0.0	0.0	-0.0022	0.0	0.0	0.0164
	KURT	0.0	0.0	1.5062	0.0	0.0	0.4522	0.0	0.0	-0.0372
ERROR= 0										
	MEAN	20.0000	19.6179	19.8130	20.0000	20.4023	20.5175	20.0000	20.1757	20.1192
	VAR	16.1245	15.4239	14.0903	8.6667	9.5614	9.2235	4.7403	4.9029	4.8374
RN	SKEW	0.0	0.0	-0.0823	0.0	0.0	-0.0766	0.0	0.0	0.0066
	KURT	0.0	0.0	-0.1321	0.0	0.0	0.0144	0.0	0.0	0.0593
	MEAN	20.0000	23.4199	23.4874	20.0000	22.6393	22.5593	20.0000	22.8489	22.9106
	VAR	16.1245	16.2421	15.5696	8.6667	8.6641	8.7138	4.7403	4.6652	4.7266
RN	SKEW	0.0	0.0	0.1033	0.0	0.0	-0.1289	0.0	0.0	-0.0233
	KURT	0.0	0.0	1.1206	0.0	0.0	0.3698	0.0	0.0	-0.1247
ERROR= 33										
	MEAN	20.0000	22.2593	22.6871	20.0000	24.1923	24.6259	20.0000	27.2258	27.4992
	VAR	16.1245	14.8841	13.9714	8.6667	9.1010	9.0914	4.7403	4.5207	5.0165
RN	SKEW	0.0	0.0	-0.1589	0.0	0.0	-0.1796	0.0	0.0	-0.0679
	KURT	0.0	0.0	0.0676	0.0	0.0	-0.1464	0.0	0.0	0.0344
	MEAN	20.0000	28.0234	29.1621	20.0000	29.7257	29.8089	20.0000	29.4946	29.4073
	VAR	16.1245	15.0772	15.5470	8.6667	8.0334	8.2217	4.7403	4.3064	4.4222
RN	SKEW	0.0	0.0	0.5284	0.0	0.0	0.0873	0.0	0.0	-0.1130
	KURT	0.0	0.0	2.4131	0.0	0.0	0.0001	0.0	0.0	0.0387
ERROR= 67										
	MEAN	20.0000	27.3720	29.0995	20.0000	32.2036	32.8589	20.0000	36.9686	37.1055
	VAR	16.1245	13.0472	15.0097	8.6667	8.0251	8.3593	4.7403	3.7144	5.7096
RN	SKEW	0.0	0.0	-0.3627	0.0	0.0	-0.2390	0.0	0.0	0.0231
	KURT	0.0	0.0	1.1697	0.0	0.0	0.1613	0.0	0.0	-0.0919
	MEAN	20.0000	34.4340	34.6446	20.0000	35.0664	35.2079	20.0000	34.9207	34.9515
	VAR	16.1245	13.4795	14.4894	8.6667	7.1444	7.7479	4.7403	3.8915	4.3094
RN	SKEW	0.0	0.0	0.1528	0.0	0.0	0.1300	0.0	0.0	-0.0096
	KURT	0.0	0.0	0.8692	0.0	0.0	0.1110	0.0	0.0	0.3072
ERROR=100										
	MEAN	20.0000	33.3351	34.8648	20.0000	38.7479	38.9663	20.0000	42.4165	42.8144
	VAR	16.1245	12.4443	14.2316	8.6667	6.7933	7.8293	4.7403	3.0214	6.8465
RN	SKEW	0.0	0.0	-0.3129	0.0	0.0	-0.1640	0.0	0.0	0.0521
	KURT	0.0	0.0	0.3033	0.0	0.0	0.5162	0.0	0.0	0.0133

TABLE 13 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.90

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECT T	EXPECT D	OBSERVED	EXPECT T	EXPECT D	OBSERVED	EXPECT T	EXPECT D	OBSERVED
	MEAN	5.0000	4.9176	5.3107	5.0000	4.9544	5.0002	5.0000	5.0347	5.0293
	VAR	8.7856	9.8212	8.1562	4.7221	4.8711	4.9714	2.5828	2.6025	2.6431
RN	SKEW	0.0	0.0	0.1679	0.0	0.0	-0.0733	0.0	0.0	0.0276
	KURT	0.0	0.0	2.0527	0.0	0.0	0.0942	0.0	0.0	0.1256
ERROR= 0										
	MEAN	5.0000	4.5347	4.5419	5.0000	5.0133	4.9468	5.0000	5.0046	4.9469
	VAR	8.7856	7.9382	7.8125	4.7221	5.1067	4.9437	2.5828	2.6495	2.6546
RN	SKEW	0.0	0.0	-0.1534	0.0	0.0	-0.0635	0.0	0.0	0.0771
	KURT	0.0	0.0	0.0711	0.0	0.0	-0.1140	0.0	0.0	-0.1792
	MEAN	5.0000	5.5415	5.2584	5.0000	9.4868	9.5068	5.0000	9.3746	9.4206
	VAR	8.7856	10.1382	9.1259	4.7221	5.5547	5.4550	2.5828	2.9428	3.0026
RN	SKEW	0.0	0.0	0.2674	0.0	0.0	-0.0421	0.0	0.0	-0.0663
	KURT	0.0	0.0	1.7536	0.0	0.0	0.1977	0.0	0.0	0.2533
ERROR= 33										
	MEAN	5.0000	8.3973	9.6209	5.0000	10.8559	11.4514	5.0000	15.5527	16.0176
	VAR	8.7856	8.9619	9.2388	4.7221	5.8981	6.0095	2.5828	3.2959	4.6763
RN	SKEW	0.0	0.0	-0.2943	0.0	0.0	-0.3973	0.0	0.0	-0.0690
	KURT	0.0	0.0	0.1566	0.0	0.0	0.4048	0.0	0.0	-0.0356
	MEAN	5.0000	13.7141	13.0959	5.0000	19.1323	19.1801	5.0000	19.0989	19.1251
	VAR	8.7856	12.0434	11.7561	4.7221	6.2005	6.3003	2.5828	3.3284	3.3276
RN	SKEW	0.0	0.0	0.1823	0.0	0.0	0.1002	0.0	0.0	-0.0483
	KURT	0.0	0.0	1.2893	0.0	0.0	0.1707	0.0	0.0	-0.0490
ERROR= 67										
	MEAN	5.0000	18.1528	18.4635	5.0000	23.5831	24.2166	5.0000	30.6148	31.2150
	VAR	8.7856	10.3412	11.3235	4.7221	6.3278	6.4923	2.5828	3.2272	6.0181
RN	SKEW	0.0	0.0	-0.4441	0.0	0.0	-0.1902	0.0	0.0	0.0409
	KURT	0.0	0.0	0.9772	0.0	0.0	0.0914	0.0	0.0	0.0621
	MEAN	5.0000	27.4874	27.2419	5.0000	27.4984	27.5922	5.0000	27.5321	27.6139
	VAR	8.7856	11.3436	12.4505	4.7221	6.0926	6.5412	2.5828	3.3229	3.7015
RN	SKEW	0.0	0.0	0.1070	0.0	0.0	-0.1144	0.0	0.0	-0.0508
	KURT	0.0	0.0	0.6301	0.0	0.0	-0.0856	0.0	0.0	0.1773
ERROR=100										
	MEAN	5.0000	25.2910	27.3282	5.0000	33.0360	33.4434	5.0000	38.4703	38.6870
	VAR	8.7856	10.2004	12.6093	4.7221	5.8067	6.9984	2.5828	2.7947	7.1033
RN	SKEW	0.0	0.0	-0.0144	0.0	0.0	0.1130	0.0	0.0	0.1313
	KURT	0.0	0.0	0.6038	0.0	0.0	0.1205	0.0	0.0	-0.1660

TABLE 1. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	50.0000	49.9010	50.2251	50.0000	50.0326	50.0130	50.0000	50.1996	50.1497
	VAR	20.1556	19.3935	19.2632	10.8333	10.7002	11.2463	5.9254	5.9160	6.0236
RR	SKEW	0.0	0.0	-0.0166	0.0	0.0	-0.1305	0.0	0.0	0.0936
	KURT	0.0	0.0	0.6017	0.0	0.0	0.0321	0.0	0.0	0.1327
ERROR= 0										
	MEAN	50.0000	51.2472	51.1547	50.0000	49.7994	49.7130	50.0000	50.0766	50.0943
	VAR	20.1555	13.9731	17.6760	10.8333	10.2307	9.7614	5.9254	5.8262	5.5358
FR	SKEW	0.0	0.0	0.0997	0.0	0.0	-0.0689	0.0	0.0	-0.1605
	KURT	0.0	0.0	0.0282	0.0	0.0	-0.2389	0.0	0.0	-0.0191
	MEAN	50.0000	49.3441	49.3301	50.0000	50.1457	50.1534	50.0000	50.0068	49.9344
	VAR	20.1556	14.8023	19.6545	10.8333	10.2352	10.3976	5.9254	5.6172	5.8977
RR	SKEW	0.0	0.0	0.0372	0.0	0.0	0.0003	0.0	0.0	-0.0018
	KURT	0.0	0.0	1.1515	0.0	0.0	0.5203	0.0	0.0	-0.2414
ERROR= 33										
	MEAN	50.0000	50.2844	50.2554	50.0000	50.1304	50.1745	50.0000	49.9423	49.8898
	VAR	20.1556	18.1308	17.3802	10.8333	9.8135	9.2545	5.9254	5.3184	5.3959
FR	SKEW	0.0	0.0	0.0647	0.0	0.0	0.0484	0.0	0.0	-0.0189
	KURT	0.0	0.0	0.3522	0.0	0.0	0.0459	0.0	0.0	-0.1634
	MEAN	50.0000	50.2867	50.2612	50.0000	49.9795	49.9432	50.0000	49.9242	49.9749
	VAR	20.1556	16.7346	17.6345	10.8333	9.0608	9.5746	5.9254	4.9582	5.3141
RR	SKEW	0.0	0.0	0.0043	0.0	0.0	-0.0164	0.0	0.0	-0.0584
	KURT	0.0	0.0	0.6721	0.0	0.0	0.4370	0.0	0.0	-0.1306
ERROR= 67										
	MEAN	50.0000	49.3630	49.5436	50.0000	49.9726	49.8322	50.0000	49.8680	49.8351
	VAR	20.1556	16.3171	16.8972	10.8333	8.8172	8.6681	5.9254	4.3873	4.7940
FR	SKEW	0.0	0.0	-0.1547	0.0	0.0	0.0394	0.0	0.0	0.0787
	KURT	0.0	0.0	0.7341	0.0	0.0	0.2460	0.0	0.0	0.1380
	MEAN	50.0000	49.2134	49.6186	50.0000	50.4241	50.2885	50.0000	49.8623	49.8758
	VAR	20.1556	14.4373	15.4510	10.8333	7.7724	8.4280	5.9254	4.2562	4.6171
RR	SKEW	0.0	0.0	-0.0665	0.0	0.0	0.0068	0.0	0.0	0.0275
	KURT	0.0	0.0	0.7684	0.0	0.0	0.1373	0.0	0.0	-0.1014
ERROR=100										
	MEAN	50.0000	49.1756	49.5042	50.0000	50.0600	49.9771	50.0000	50.1102	50.1583
	VAR	20.1555	14.2438	15.3565	10.8333	7.6546	7.7559	5.9254	3.5332	4.8963
FR	SKEW	0.0	0.0	0.1006	0.0	0.0	0.1030	0.0	0.0	-0.2013
	KURT	0.0	0.0	1.5712	0.0	0.0	-0.3325	0.0	0.0	0.0090

TABLE 15. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.30

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	35.0000	35.0171	35.2023	35.0000	34.2485	34.5034	35.0000	34.9744	34.9104
	VAR	19.2273	19.0405	19.2579	10.3343	10.1552	10.0395	5.6525	5.6393	5.6555
RR	SKEW	0.0	0.0	0.1013	0.0	0.0	0.0234	0.0	0.0	-0.0770
	KURT	0.0	0.0	0.7373	0.0	0.0	0.1478	0.0	0.0	0.1619
ERROR= 0										
	MEAN	35.0000	34.5775	34.7164	35.0000	34.7822	34.7980	35.0000	33.7343	35.2101
	VAR	19.2273	18.0161	16.4912	10.3343	9.8356	9.0236	5.6525	6.0568	5.3464
RR	SKEW	0.0	0.0	-0.1246	0.0	0.0	-0.1489	0.0	0.0	-0.0501
	KURT	0.0	0.0	0.3606	0.0	0.0	0.0854	0.0	0.0	-0.0286
	MEAN	35.0000	37.3405	37.6268	35.0000	36.5047	36.6785	35.0000	36.3937	36.4449
	VAR	19.2273	17.7098	17.4586	10.3343	9.8539	9.9703	5.6525	5.4197	5.4278
RR	SKEW	0.0	0.0	0.0469	0.0	0.0	0.1206	0.0	0.0	-0.0632
	KURT	0.0	0.0	0.3108	0.0	0.0	0.3156	0.0	0.0	-0.1440
ERROR= 33										
	MEAN	35.0000	35.5914	36.0856	35.0000	36.3057	36.4446	35.0000	35.7936	37.4361
	VAR	19.2273	17.5611	16.3531	10.3343	9.4242	9.4141	5.6525	5.5361	5.1893
RR	SKEW	0.0	0.0	-0.0329	0.0	0.0	-0.1610	0.0	0.0	0.0073
	KURT	0.0	0.0	0.2007	0.0	0.0	0.0516	0.0	0.0	0.1450
	MEAN	35.0000	39.6687	39.5630	35.0000	39.3018	39.4126	35.0000	39.4916	39.4638
	VAR	19.2273	16.2925	17.0347	10.3343	8.7210	9.2299	5.6525	4.7813	5.1342
RR	SKEW	0.0	0.0	-0.0129	0.0	0.0	-0.0498	0.0	0.0	-0.1203
	KURT	0.0	0.0	0.4330	0.0	0.0	0.1927	0.0	0.0	0.1739
ERROR= 67										
	MEAN	35.0000	37.6942	38.2571	35.0000	38.8259	38.9604	35.0000	40.4159	42.0196
	VAR	19.2273	15.7957	15.5933	10.3343	8.4946	8.5948	5.6525	4.6575	4.9980
RR	SKEW	0.0	0.0	-0.0614	0.0	0.0	-0.0735	0.0	0.0	-0.0518
	KURT	0.0	0.0	0.3320	0.0	0.0	-0.0664	0.0	0.0	0.1123
	MEAN	35.0000	41.6870	42.1722	35.0000	42.2341	42.1324	35.0000	42.6532	42.7121
	VAR	19.2273	14.1585	15.0336	10.3343	7.6827	8.3229	5.6525	4.1801	4.4898
RR	SKEW	0.0	0.0	-0.1508	0.0	0.0	-0.0250	0.0	0.0	0.0018
	KURT	0.0	0.0	1.5408	0.0	0.0	-0.0509	0.0	0.0	-0.1722
ERROR=100										
	MEAN	35.0000	40.5317	41.3334	35.0000	42.4485	42.4803	35.0000	44.7901	44.6841
	VAR	19.2273	14.2235	14.4059	10.3343	7.5218	7.6266	5.6525	3.5599	4.9437
RR	SKEW	0.0	0.0	-0.2867	0.0	0.0	-0.0690	0.0	0.0	-0.0730
	KURT	0.0	0.0	1.3918	0.0	0.0	-0.0356	0.0	0.0	0.1568

TABLE 2: SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.63

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	20.0000	20.5329	20.4413	20.0000	20.3314	20.2202	20.0000	20.0828	20.0923
	VAR	16.1245	16.4259	15.7841	8.6667	8.6719	8.6976	4.7403	4.7326	4.8659
RR	SKEW	0.0	0.0	-0.0260	0.0	0.0	0.0	0.0	0.0	0.1410
	KURT	0.0	0.0	0.8783	0.0	0.0	0.1729	0.0	0.0	-0.0736
ERROR= 0										
	MEAN	20.0000	20.4832	20.3121	20.0000	20.3447	20.3873	20.0000	19.8049	19.7895
	VAR	16.1245	15.5277	14.9172	8.6667	8.1900	8.1417	4.7403	4.6573	4.6369
FR	SKEW	0.0	0.0	0.0531	0.0	0.0	-0.0927	0.0	0.0	-0.0443
	KURT	0.0	0.0	0.0942	0.0	0.0	-0.1292	0.0	0.0	0.1587
	MEAN	20.0000	23.0342	22.9859	20.0000	22.3857	22.6666	20.0000	22.5374	22.5794
	VAR	16.1245	16.0132	15.4723	8.6667	8.4237	8.3028	4.7403	4.6332	4.6545
RR	SKEW	0.0	0.0	-0.0895	0.0	0.0	0.0142	0.0	0.0	-0.0484
	KURT	0.0	0.0	0.9905	0.0	0.0	0.0969	0.0	0.0	-0.0463
ERROR= 33										
	MEAN	20.0000	21.1887	21.8544	20.0000	22.5329	22.5724	20.0000	24.7094	24.9121
	VAR	16.1245	14.9965	14.1477	8.6667	8.0393	7.7491	4.7403	4.4789	4.7499
FR	SKEW	0.0	0.0	-0.1277	0.0	0.0	-0.1812	0.0	0.0	-0.2489
	KURT	0.0	0.0	0.2520	0.0	0.0	0.1999	0.0	0.0	0.1529
	MEAN	20.0000	28.1353	28.8534	20.0000	28.9404	29.1675	20.0000	29.0402	29.0502
	VAR	16.1245	14.4508	15.0649	8.6667	7.8437	7.7483	4.7403	4.3084	4.3040
RR	SKEW	0.0	0.0	-0.1113	0.0	0.0	0.0264	0.0	0.0	-0.0029
	KURT	0.0	0.0	1.5513	0.0	0.0	0.4501	0.0	0.0	0.0259
ERROR= 67										
	MEAN	20.0000	27.0694	28.2771	20.0000	27.7259	28.2338	20.0000	33.3234	33.5467
	VAR	16.1245	14.3050	13.8385	8.6667	7.6038	7.1050	4.7403	3.9386	4.5727
FR	SKEW	0.0	0.0	-0.4575	0.0	0.0	-0.1227	0.0	0.0	-0.1814
	KURT	0.0	0.0	0.9922	0.0	0.0	0.0233	0.0	0.0	0.2506
	MEAN	20.0000	33.5247	33.7388	20.0000	34.4260	34.6342	20.0000	35.0505	35.0338
	VAR	16.1245	13.1564	13.5691	8.6667	7.0431	7.6383	4.7403	3.8690	4.1183
RR	SKEW	0.0	0.0	-0.1306	0.0	0.0	0.0015	0.0	0.0	0.0565
	KURT	0.0	0.0	0.9789	0.0	0.0	0.1269	0.0	0.0	-0.0726
ERROR=100										
	MEAN	20.0000	33.2906	34.1166	20.0000	33.9819	34.4238	20.0000	39.3252	39.3197
	VAR	16.1245	13.0791	12.7287	8.6667	6.8977	6.5846	4.7403	3.3556	4.7547
FR	SKEW	0.0	0.0	-0.2585	0.0	0.0	-0.1538	0.0	0.0	-0.0376
	KURT	0.0	0.0	1.1945	0.0	0.0	0.4099	0.0	0.0	0.0253

TABLE 17 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.90

		SAMPLE SIZE								
		N=5			N=13			N=39		
		EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED	EXPECTED	EXPECTED	OBSERVED
	MEAN	5.0000	5.1997	5.4656	5.0000	5.2087	5.2482	5.0000	5.0601	5.0914
	VAR	8.7856	9.2221	8.4980	4.7221	4.7595	4.8267	2.5828	2.5827	2.5995
RR	SKEW	0.0	0.0	0.0506	0.0	0.0	0.0493	0.0	0.0	0.0522
	KURT	0.0	0.0	0.6001	0.0	0.0	0.2165	0.0	0.0	-0.0931
ERROR= 0										
	MEAN	5.0000	4.7164	4.6774	5.0000	4.9319	4.9812	5.0000	5.1108	5.0873
	VAR	8.7856	7.9304	8.0321	4.7221	4.4196	4.4217	2.5828	2.5274	2.5479
FR	SKEW	0.0	0.0	-0.1580	0.0	0.0	0.0288	0.0	0.0	-0.0175
	KURT	0.0	0.0	0.0781	0.0	0.0	-0.2499	0.0	0.0	0.1027
	MEAN	5.0000	9.1217	9.4853	5.0000	9.1770	9.3720	5.0000	9.3229	9.3188
	VAR	8.7856	10.5217	9.7634	4.7221	5.3048	5.0345	2.5828	2.9173	2.9995
RR	SKEW	0.0	0.0	0.0425	0.0	0.0	-0.2131	0.0	0.0	-0.1360
	KURT	0.0	0.0	0.5389	0.0	0.0	0.3552	0.0	0.0	0.1688
ERROR= 33										
	MEAN	5.0000	7.4582	8.6013	5.0000	8.6824	8.9866	5.0000	11.9083	12.2650
	VAR	8.7856	9.0970	9.1411	4.7221	4.9992	5.0378	2.5828	3.0635	3.6573
FR	SKEW	0.0	0.0	-0.2877	0.0	0.0	-0.0807	0.0	0.0	-0.3092
	KURT	0.0	0.0	0.2211	0.0	0.0	-0.0439	0.0	0.0	0.2384
	MEAN	5.0000	18.0602	17.9802	5.0000	18.4544	18.8774	5.0000	18.8665	18.9684
	VAR	8.7856	11.5499	10.9489	4.7221	5.9840	5.8170	2.5828	3.2982	3.3254
RR	SKEW	0.0	0.0	-0.1210	0.0	0.0	-0.0365	0.0	0.0	-0.0643
	KURT	0.0	0.0	1.0567	0.0	0.0	-0.0356	0.0	0.0	0.0040
ERROR= 67										
	MEAN	5.0000	14.7053	16.6703	5.0000	16.8174	17.4123	5.0000	24.9906	25.1947
	VAR	8.7856	10.7371	10.0950	4.7221	5.8416	5.2838	2.5828	3.2996	4.0139
FR	SKEW	0.0	0.0	-0.6775	0.0	0.0	-0.2119	0.0	0.0	-0.1303
	KURT	0.0	0.0	1.4015	0.0	0.0	0.3272	0.0	0.0	0.0628
	MEAN	5.0000	26.1537	26.9659	5.0000	26.8392	27.0535	5.0000	27.3281	27.3530
	VAR	8.7856	11.5456	11.9180	4.7221	6.0804	6.1756	2.5828	3.3024	3.3516
RR	SKEW	0.0	0.0	-0.0887	0.0	0.0	-0.0029	0.0	0.0	0.0706
	KURT	0.0	0.0	1.0402	0.0	0.0	0.3141	0.0	0.0	0.0175
ERROR=100										
	MEAN	5.0000	25.4134	26.6484	5.0000	25.7303	26.2514	5.0000	34.1283	34.2668
	VAR	8.7856	11.5762	10.6681	4.7221	5.9598	5.5077	2.5828	3.0300	4.6934
FR	SKEW	0.0	0.0	-0.3219	0.0	0.0	-0.3487	0.0	0.0	0.0427
	KURT	0.0	0.0	1.2146	0.0	0.0	0.5193	0.0	0.0	-0.1051

TABLE 13 SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.9

			SAMPLE SIZE					
			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
		SLOPE-MEAN F	1.5000	1.4260	1.1000	1.1198	1.0278	1.0380
		SLOPE-I ERROR	50/ 10	47/ 9	50/ 10	52/ 15	50/ 10	53/ 14
	RN	INTERCEPT-MEAN F	1.4000	1.4975	1.0952	1.1447	1.0274	1.0287
		INTERCEPT-I ERROR	50/ 10	46/ 13	50/ 10	60/ 9	50/ 10	46/ 8
ERROR= 0								
		SLOPE-MEAN F	1.5000	1.4473	1.1000	0.9953	1.0278	1.1104
		SLOPE-I ERROR	50/ 10	50/ 9	50/ 10	42/ 9	50/ 10	60/ 14
	FN	INTERCEPT-MEAN F	1.4000	1.4863	1.0952	1.0386	1.0274	1.0917
		INTERCEPT-I ERROR	50/ 10	42/ 8	50/ 10	40/ 7	50/ 10	62/ 17
		SLOPE-MEAN F	1.5000	1.3070	1.1000	1.1073	1.0278	1.0035
		SLOPE-I ERROR	50/ 10	44/ 5	50/ 10	63/ 9	50/ 10	39/ 8
	RN	INTERCEPT-MEAN F	1.4000	1.3417	1.0952	1.1579	1.0274	0.9157
		INTERCEPT-I ERROR	50/ 10	44/ 7	50/ 10	56/ 8	50/ 10	48/ 14
ERROR= 33								
		SLOPE-MEAN F	1.5000	1.3483	1.1000	1.0967	1.0278	1.0321
		SLOPE-I ERROR	50/ 10	43/ 8	50/ 10	54/ 13	50/ 10	47/ 9
	FN	INTERCEPT-MEAN F	1.4000	1.4646	1.0952	1.1295	1.0274	1.0122
		INTERCEPT-I ERROR	50/ 10	44/ 10	50/ 10	48/ 6	50/ 10	49/ 10
		SLOPE-MEAN F	1.5000	1.3557	1.1000	1.1030	1.0278	0.9851
		SLOPE-I ERROR	50/ 10	52/ 11	50/ 10	56/ 9	50/ 10	52/ 10
	RN	INTERCEPT-MEAN F	1.4000	1.5364	1.0952	1.0946	1.0274	1.0352
		INTERCEPT-I ERROR	50/ 10	48/ 13	50/ 10	49/ 10	50/ 10	43/ 8
ERROR= 67								
		SLOPE-MEAN F	1.5000	1.3282	1.1000	1.1571	1.0278	1.0200
		SLOPE-I ERROR	50/ 10	40/ 9	50/ 10	48/ 15	50/ 10	39/ 7
	FN	INTERCEPT-MEAN F	1.4000	1.4764	1.0952	1.1159	1.0274	0.9615
		INTERCEPT-I ERROR	50/ 10	46/ 12	50/ 10	61/ 12	50/ 10	45/ 6
		SLOPE-MEAN F	1.5000	1.5032	1.1000	1.0675	1.0278	1.0385
		SLOPE-I ERROR	50/ 10	51/ 13	50/ 10	56/ 13	50/ 10	48/ 13
	RN	INTERCEPT-MEAN F	1.4000	1.4474	1.0952	1.1226	1.0274	1.0067
		INTERCEPT-I ERROR	50/ 10	53/ 12	50/ 10	36/ 11	50/ 10	52/ 10
ERROR=100								
		SLOPE-MEAN F	1.5000	1.3637	1.1000	1.1303	1.0278	0.9214
		SLOPE-I ERROR	50/ 10	58/ 12	50/ 10	50/ 7	50/ 10	61/ 16
	FN	INTERCEPT-MEAN F	1.4000	1.5107	1.0952	1.0957	1.0274	1.0840
		INTERCEPT-I ERROR	50/ 10	48/ 12	50/ 10	46/ 12	50/ 10	34/ 4

TABLE 12. SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.33

		SAMPLE SIZE					
		N=5		N=13		N=39	
		EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	SLOPE-MEAN F	1.5000	1.4721	1.1000	1.1209	1.0278	1.0052
	SLOPE-I ERROR	50/ 10	51/ 9	50/ 10	47/ 12	50/ 10	58/ 12
RN	INTERCEPT-MEAN F	1.4000	1.4933	1.0952	1.0892	1.0274	1.0640
	INTERCEPT-I ERROR	50/ 10	56/ 10	50/ 10	51/ 12	50/ 10	52/ 8
	SLOPE-MEAN F	1.5000	1.4380	1.1000	1.0765	1.0278	1.0415
	SLOPE-I ERROR	50/ 10	47/ 9	50/ 10	48/ 12	50/ 10	47/ 10
FN	INTERCEPT-MEAN F	1.4000	1.4420	1.0952	1.1166	1.0274	1.0052
	INTERCEPT-I ERROR	50/ 10	51/ 14	50/ 10	48/ 7	50/ 10	47/ 9
ERROR= 33	SLOPE-MEAN F	1.5000	1.3160	1.1000	1.1299	1.0278	0.9792
	SLOPE-I ERROR	50/ 10	56/ 10	50/ 10	53/ 7	50/ 10	45/ 9
RN	INTERCEPT-MEAN F	1.4000	1.5570	1.0952	1.1355	1.0274	1.0215
	INTERCEPT-I ERROR	50/ 10	45/ 6	50/ 10	52/ 9	50/ 10	47/ 8
	SLOPE-MEAN F	1.5000	1.4046	1.1000	1.0790	1.0278	1.0375
	SLOPE-I ERROR	50/ 10	43/ 8	50/ 10	48/ 5	50/ 10	50/ 9
FN	INTERCEPT-MEAN F	1.4000	1.4616	1.0952	1.0349	1.0274	1.0045
	INTERCEPT-I ERROR	50/ 10	43/ 12	50/ 10	49/ 10	50/ 10	55/ 13
ERROR= 67	SLOPE-MEAN F	1.5000	1.3148	1.1000	1.0455	1.0278	0.9953
	SLOPE-I ERROR	50/ 10	41/ 4	50/ 10	48/ 13	50/ 10	54/ 14
RN	INTERCEPT-MEAN F	1.4000	1.3910	1.0952	1.0752	1.0274	1.0016
	INTERCEPT-I ERROR	50/ 10	48/ 8	50/ 10	40/ 8	50/ 10	51/ 8
	SLOPE-MEAN F	1.5000	1.4333	1.1000	1.1194	1.0278	1.0250
	SLOPE-I ERROR	50/ 10	44/ 9	50/ 10	55/ 8	50/ 10	37/ 5
FN	INTERCEPT-MEAN F	1.4000	1.5136	1.0952	1.0893	1.0274	1.0191
	INTERCEPT-I ERROR	50/ 10	55/ 10	50/ 10	48/ 10	50/ 10	49/ 13
ERROR=100	SLOPE-MEAN F	1.5000	1.5678	1.1000	1.0823	1.0278	1.0284
	SLOPE-I ERROR	50/ 10	52/ 12	50/ 10	63/ 14	50/ 10	51/ 10
RN	INTERCEPT-MEAN F	1.4000	1.6037	1.0952	1.1640	1.0274	1.0280
	INTERCEPT-I ERROR	50/ 10	64/ 13	50/ 10	43/ 8	50/ 10	44/ 11
	SLOPE-MEAN F	1.5000	1.4202	1.1000	1.0345	1.0278	0.9811
	SLOPE-I ERROR	50/ 10	36/ 5	50/ 10	43/ 10	50/ 10	59/ 11
FN	INTERCEPT-MEAN F	1.4000	1.3108	1.0952	1.0546	1.0274	1.1070
	INTERCEPT-I ERROR	50/ 10	52/ 15	50/ 10	47/ 6	50/ 10	40/ 8

TABLE 29. SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

		SAMPLE SIZE					
		N=5		N=13		N=39	
		EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	SLOPE-MEAN F	1.5000	1.4850	1.1000	1.0499	1.0278	1.0413
	SLOPE-I ERROR	50/ 10	54/ 8	50/ 10	55/ 14	50/ 10	53/ 9
	RN INTERCEPT-MEAN F	1.4000	1.4481	1.0952	1.1141	1.0274	1.0350
	INTERCEPT-I ERROR	50/ 10	54/ 13	50/ 10	53/ 5	50/ 10	54/ 7
	SLOPE-MEAN F	1.5000	1.5427	1.1000	1.1372	1.0278	0.9627
	SLOPE-I ERROR	50/ 10	41/ 5	50/ 10	47/ 11	50/ 10	56/ 11
	FN INTERCEPT-MEAN F	1.4000	1.3129	1.0952	1.0740	1.0274	1.0908
	INTERCEPT-I ERROR	50/ 10	58/ 12	50/ 10	50/ 11	50/ 10	43/ 9
ERROR= 33	SLOPE-MEAN F	1.5000	1.4632	1.1000	1.0677	1.0278	1.0252
	SLOPE-I ERROR	50/ 10	53/ 10	50/ 10	51/ 8	50/ 10	59/ 8
	RN INTERCEPT-MEAN F	1.4000	1.4661	1.0952	1.0893	1.0274	1.0803
	INTERCEPT-I ERROR	50/ 10	62/ 16	50/ 10	49/ 10	50/ 10	49/ 12
	SLOPE-MEAN F	1.5000	1.3338	1.1000	1.1626	1.0278	1.3308
	SLOPE-I ERROR	50/ 10	42/ 5	50/ 10	54/ 12	50/ 10	55/ 11
	FN INTERCEPT-MEAN F	1.4000	1.2806	1.0952	1.1629	1.0274	1.1657
	INTERCEPT-I ERROR	50/ 10	49/ 10	50/ 10	61/ 13	50/ 10	58/ 12
ERROR= 67	SLOPE-MEAN F	1.5000	1.3804	1.1000	1.0239	1.0278	1.1050
	SLOPE-I ERROR	50/ 10	54/ 13	50/ 10	47/ 7	50/ 10	50/ 10
	RN INTERCEPT-MEAN F	1.4000	1.6271	1.0952	1.1013	1.0274	1.0304
	INTERCEPT-I ERROR	50/ 10	50/ 9	50/ 10	45/ 9	50/ 10	54/ 12
	SLOPE-MEAN F	1.5000	1.5764	1.1000	1.0810	1.0278	1.3130
	SLOPE-I ERROR	50/ 10	54/ 10	50/ 10	40/ 8	50/ 10	59/ 12
	FN INTERCEPT-MEAN F	1.4000	1.3613	1.0952	1.0326	1.0274	1.2754
	INTERCEPT-I ERROR	50/ 10	70/ 14	50/ 10	50/ 4	50/ 10	60/ 11
ERROR=100	SLOPE-MEAN F	1.5000	1.4383	1.1000	1.1934	1.0278	0.8961
	SLOPE-I ERROR	50/ 10	41/ 5	50/ 10	42/ 6	50/ 10	50/ 10
	RN INTERCEPT-MEAN F	1.4000	1.3401	1.0952	1.0323	1.0274	1.0295
	INTERCEPT-I ERROR	50/ 10	51/ 14	50/ 10	54/ 20	50/ 10	31/ 8
	SLOPE-MEAN F	1.5000	1.4631	1.1000	0.9658	1.0278	1.0360
	SLOPE-I ERROR	50/ 10	44/ 5	50/ 10	51/ 8	50/ 10	56/ 13
	FN INTERCEPT-MEAN F	1.4000	1.3593	1.0952	1.0947	1.0274	1.3862
	INTERCEPT-I ERROR	50/ 10	49/ 14	50/ 10	42/ 5	50/ 10	51/ 10

TABLE 21 SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.90

			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
		SLOPE-MEAN F	1.5000	1.2731	1.1000	1.1329	1.0278	1.0176
		SLOPE-I ERROR	50/ 10	43/ 11	50/ 10	50/ 9	50/ 10	47/ 7
	RN	INTERCEPT-MEAN F	1.4000	1.4702	1.0952	1.1056	1.0274	1.0097
		INTERCEPT-I ERROR	50/ 10	39/ 7	50/ 10	47/ 8	50/ 10	54/ 11
ERROR= 0								
		SLOPE-MEAN F	1.5000	1.5472	1.1000	1.0990	1.0278	1.0804
		SLOPE-I ERROR	50/ 10	55/ 19	50/ 10	45/ 10	50/ 10	38/ 7
	FN	INTERCEPT-MEAN F	1.4000	1.3422	1.0952	1.1101	1.0274	0.9658
		INTERCEPT-I ERROR	50/ 10	59/ 16	50/ 10	53/ 12	50/ 10	54/ 14
		SLOPE-MEAN F	1.5000	1.4263	1.1000	1.1493	1.0278	0.9788
		SLOPE-I ERROR	50/ 10	49/ 6	50/ 10	49/ 7	50/ 10	50/ 6
	RN	INTERCEPT-MEAN F	1.4000	1.3605	1.0952	1.0535	1.0274	1.0265
		INTERCEPT-I ERROR	50/ 10	51/ 10	50/ 10	56/ 9	50/ 10	41/ 9
ERROR= 33								
		SLOPE-MEAN F	1.5000	1.8410	1.1000	1.2603	1.0278	2.2788
		SLOPE-I ERROR	50/ 10	45/ 6	50/ 10	55/ 10	50/ 10	52/ 12
	FN	INTERCEPT-MEAN F	1.4000	1.4966	1.0952	1.1661	1.0274	1.6844
		INTERCEPT-I ERROR	50/ 10	80/ 15	50/ 10	65/ 9	50/ 10	58/ 16
		SLOPE-MEAN F	1.5000	1.3829	1.1000	1.0777	1.0278	0.9642
		SLOPE-I ERROR	50/ 10	52/ 12	50/ 10	51/ 4	50/ 10	43/ 7
	RN	INTERCEPT-MEAN F	1.4000	1.5179	1.0952	1.0136	1.0274	1.0108
		INTERCEPT-I ERROR	50/ 10	58/ 10	50/ 10	44/ 10	50/ 10	42/ 9
ERROR= 67								
		SLOPE-MEAN F	1.5000	1.5612	1.1000	1.1638	1.0278	1.7389
		SLOPE-I ERROR	50/ 10	42/ 3	50/ 10	35/ 11	50/ 10	58/ 15
	FN	INTERCEPT-MEAN F	1.4000	1.2115	1.0952	1.0149	1.0274	1.8596
		INTERCEPT-I ERROR	50/ 10	56/ 15	50/ 10	56/ 10	50/ 10	54/ 14
		SLOPE-MEAN F	1.5000	1.2730	1.1000	1.1237	1.0278	0.9924
		SLOPE-I ERROR	50/ 10	56/ 10	50/ 10	46/ 11	50/ 10	45/ 9
	RN	INTERCEPT-MEAN F	1.4000	1.7063	1.0952	1.1270	1.0274	1.02[illegible]
		INTERCEPT-I ERROR	50/ 10	43/ 10	50/ 10	54/ 8	50/ 10	46/ 8
ERROR=100								
		SLOPE-MEAN F	1.5000	1.3538	1.1000	0.8281*	1.0278	1.2393
		SLOPE-I ERROR	50/ 10	17/ 5	50/ 10	34/ 6	50/ 10	57/ 16
	FN	INTERCEPT-MEAN F	1.4000	1.0772	1.0952	0.9906	1.0274	2.0209
		INTERCEPT-I ERROR	50/ 10	47/ 10	50/ 10	27/ 3	50/ 10	53/ 12

...LE 22. SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS ... X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF ... RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

		SAMPLE SIZE					
		N=5		N=13		N=...	
		EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
	SLOPE-MEAN F	1.5000	1.5544	1.1000	1.0760	1.0278	1.0436
	SLOPE-I ERROR	50/ 10	41/ 9	50/ 10	51/ 15	50/ 10	47/ 7
RR	INTERCEPT-MEAN F	1.4000	1.5257	1.0952	1.1574	1.0274	1.0275
	INTERCEPT-I ERROR	50/ 10	66/ 13	50/ 10	45/ 9	50/ 10	55/ 15
ERROR= 0							
	SLOPE-MEAN F	1.5000	1.5016	1.1000	1.0084	1.0278	0.9995
	SLOPE-I ERROR	50/ 10	43/ 9	50/ 10	51/ 9	50/ 10	50/ 12
FR	INTERCEPT-MEAN F	1.4000	1.4510	1.0952	1.0994	1.0274	1.0317
	INTERCEPT-I ERROR	50/ 10	44/ 12	50/ 10	41/ 8	50/ 10	44/ 9
	SLOPE-MEAN F	1.5000	1.3972	1.1000	1.1127	1.0278	0.9706
	SLOPE-I ERROR	50/ 10	53/ 12	50/ 10	44/ 9	50/ 10	50/ 13
RR	INTERCEPT-MEAN F	1.4000	1.6090	1.0952	1.0911	1.0274	1.0923
	INTERCEPT-I ERROR	50/ 10	50/ 12	50/ 10	48/ 11	50/ 10	43/ 7
ERROR= 33							
	SLOPE-MEAN F	1.5000	1.5133	1.1000	1.1558	1.0278	1.0618
	SLOPE-I ERROR	50/ 10	51/ 9	50/ 10	38/ 9	50/ 10	38/ 4
FR	INTERCEPT-MEAN F	1.4000	1.5776	1.0952	1.0619	1.0274	0.9393
	INTERCEPT-I ERROR	50/ 10	52/ 12	50/ 10	53/ 12	50/ 10	51/ 13
	SLOPE-MEAN F	1.5000	1.3230	1.1000	1.1556	1.0278	1.0258
	SLOPE-I ERROR	50/ 10	54/ 9	50/ 10	41/ 7	50/ 10	50/ 9
RR	INTERCEPT-MEAN F	1.4000	1.4951	1.0952	1.0455	1.0274	1.0280
	INTERCEPT-I ERROR	50/ 10	48/ 10	50/ 10	50/ 10	50/ 10	62/ 17
ERROR= 67							
	SLOPE-MEAN F	1.5000	1.5317	1.1000	1.0753	1.0278	1.0838
	SLOPE-I ERROR	50/ 10	48/ 12	50/ 10	50/ 10	50/ 10	53/ 9
FR	INTERCEPT-MEAN F	1.4000	1.4874	1.0952	1.1070	1.0274	1.0153
	INTERCEPT-I ERROR	50/ 10	47/ 11	50/ 10	42/ 13	50/ 10	69/ 16
	SLOPE-MEAN F	1.5000	1.4188	1.1000	1.0500	1.0278	0.9670
	SLOPE-I ERROR	50/ 10	33/ 5	50/ 10	57/ 15	50/ 10	41/ 11
RR	INTERCEPT-MEAN F	1.4000	1.3316	1.0952	1.1779	1.0274	1.0072
	INTERCEPT-I ERROR	50/ 10	55/ 11	50/ 10	47/ 10	50/ 10	38/ 8
ERROR=100							
	SLOPE-MEAN F	1.5000	1.2587	1.1000	1.0313	1.0278	1.0235
	SLOPE-I ERROR	50/ 10	46/ 11	50/ 10	43/ 11	50/ 10	61/ 13
FR	INTERCEPT-MEAN F	1.4000	1.5164	1.0952	1.1375	1.0274	1.0947

TABLE 23 SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS
* X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF
* RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF
ESTIMATE BASED ON A CORRELATION OF 0.30

SAMPLE SIZE

		N=5		N=13		N=39	
		EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	SLOPE-MEAN F	1.5000	1.6570	1.1000	1.1928	1.0278	1.0195
	SLOPE-I ERROR	50/ 10	44/ 11	50/ 10	54/ 9	50/ 10	43/ 10
RR	INTERCEPT-MEAN F	1.4000	1.5686	1.0952	1.0934	1.0274	1.0118
	INTERCEPT-I ERROR	50/ 10	53/ 15	50/ 10	56/ 9	50/ 10	47/ 12
	SLOPE-MEAN F	1.5000	1.3927	1.1000	1.0227	1.0278	0.8571
	SLOPE-I ERROR	50/ 10	62/ 17	50/ 10	59/ 11	50/ 10	32/ 1
FR	INTERCEPT-MEAN F	1.4000	1.7555	1.0952	1.1434	1.0274	0.8384
	INTERCEPT-I ERROR	50/ 10	48/ 10	50/ 10	36/ 14	50/ 10	25/ 4
ERROR= 33	SLOPE-MEAN F	1.5000	1.2710	1.1000	1.0987	1.0278	0.9997
	SLOPE-I ERROR	50/ 10	51/ 12	50/ 10	52/ 10	50/ 10	47/ 9
RR	INTERCEPT-MEAN F	1.4000	1.6327	1.0952	1.1006	1.0274	1.0367
	INTERCEPT-I ERROR	50/ 10	45/ 7	50/ 10	57/ 11	50/ 10	50/ 7
	SLOPE-MEAN F	1.5000	1.3775	1.1000	1.0362	1.0278	0.8837
	SLOPE-I ERROR	50/ 10	66/ 14	50/ 10	55/ 9	50/ 10	40/ 7
FR	INTERCEPT-MEAN F	1.4000	1.6696	1.0952	1.1313	1.0274	1.0114
	INTERCEPT-I ERROR	50/ 10	44/ 11	50/ 10	50/ 6	50/ 10	35/ 10
ERROR= 67	SLOPE-MEAN F	1.5000	1.2628	1.1000	1.0590	1.0278	0.9737
	SLOPE-I ERROR	50/ 10	49/ 7	50/ 10	53/ 15	50/ 10	44/ 8
RR	INTERCEPT-MEAN F	1.4000	1.4334	1.0952	1.1184	1.0274	1.0023
	INTERCEPT-I ERROR	50/ 10	42/ 5	50/ 10	42/ 5	50/ 10	42/ 14
	SLOPE-MEAN F	1.5000	1.4389	1.1000	1.0714	1.0278	0.9184
	SLOPE-I ERROR	50/ 10	52/ 5	50/ 10	56/ 12	50/ 10	45/ 11
FR	INTERCEPT-MEAN F	1.4000	1.3927	1.0952	1.1579	1.0274	1.0234
	INTERCEPT-I ERROR	50/ 10	50/ 13	50/ 10	55/ 10	50/ 10	38/ 7
ERROR=100	SLOPE-MEAN F	1.5000	1.4851	1.1000	0.9572	1.0278	0.9816
	SLOPE-I ERROR	50/ 10	47/ 9	50/ 10	42/ 8	50/ 10	39/ 5
RR	INTERCEPT-MEAN F	1.4000	1.5121	1.0952	1.1112	1.0274	1.0023
	INTERCEPT-I ERROR	50/ 10	49/ 12	50/ 10	35/ 4	50/ 10	38/ 11
	SLOPE-MEAN F	1.5000	1.2718	1.1000	1.0372	1.0278	0.9660
	SLOPE-I ERROR	50/ 10	56/ 15	50/ 10	44/ 9	50/ 10	45/ 11
FR	INTERCEPT-MEAN F	1.4000	1.5883	1.0952	0.9931	1.0274	1.0273
	INTERCEPT-I ERROR	50/ 10	39/ 9	50/ 10	47/ 11	50/ 10	49/ 6

TABLE 2. SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X. RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

			SAMPLE SIZE N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
		SLOPE-MEAN F	1.5000	1.3583	1.1000	1.0669	1.0278	1.0230
		SLOPE-I ERROR	50/ 10	43/ 7	50/ 10	50/ 12	50/ 10	51/ 14
	RR	INTERCEPT-MEAN F	1.4000	1.4336	1.0952	1.0932	1.0274	1.0922
		INTERCEPT-I ERROR	50/ 10	51/ 8	50/ 10	42/ 9	50/ 10	48/ 9
ERROR= 0								
		SLOPE-MEAN F	1.5000	1.3796	1.1000	1.1058	1.0278	1.0921
		SLOPE-I ERROR	50/ 10	54/ 13	50/ 10	48/ 7	50/ 10	53/ 10
	FR	INTERCEPT-MEAN F	1.4000	1.6164	1.0952	1.0969	1.0274	0.9861
		INTERCEPT-I ERROR	50/ 10	50/ 14	50/ 10	52/ 9	50/ 10	58/ 9
		SLOPE-MEAN F	1.5000	1.4517	1.1000	0.9895	1.0278	1.1025
		SLOPE-I ERROR	50/ 10	38/ 10	50/ 10	48/ 6	50/ 10	34/ 8
	RR	INTERCEPT-MEAN F	1.4000	1.3871	1.0952	1.0746	1.0274	0.9915
		INTERCEPT-I ERROR	50/ 10	54/ 9	50/ 10	41/ 7	50/ 10	66/ 16
ERROR= 33								
		SLOPE-MEAN F	1.5000	1.4397	1.1000	1.0686	1.0278	1.1036
		SLOPE-I ERROR	50/ 10	50/ 19	50/ 10	46/ 11	50/ 10	55/ 15
	FR	INTERCEPT-MEAN F	1.4000	1.5771	1.0952	1.0990	1.0274	1.1138
		INTERCEPT-I ERROR	50/ 10	61/ 7	50/ 10	45/ 10	50/ 10	65/ 12
		SLOPE-MEAN F	1.5000	1.4578	1.1000	1.1254	1.0278	1.0631
		SLOPE-I ERROR	50/ 10	37/ 4	50/ 10	38/ 8	50/ 10	43/ 10
	RR	INTERCEPT-MEAN F	1.4000	1.3776	1.0952	1.0802	1.0274	1.0321
		INTERCEPT-I ERROR	50/ 10	55/ 16	50/ 10	47/ 11	50/ 10	54/ 14
ERROR= 67								
		SLOPE-MEAN F	1.5000	1.4127	1.1000	1.0238	1.0278	1.0815
		SLOPE-I ERROR	50/ 10	43/ 9	50/ 10	46/ 9	50/ 10	46/ 7
	FR	INTERCEPT-MEAN F	1.4000	1.3870	1.0952	1.0406	1.0274	0.9903
		INTERCEPT-I ERROR	50/ 10	50/ 13	50/ 10	55/ 7	50/ 10	53/ 12
		SLOPE-MEAN F	1.5000	1.2724	1.1000	1.1465	1.0278	1.0906
		SLOPE-I ERROR	50/ 10	53/ 9	50/ 10	46/ 12	50/ 10	51/ 10
	RR	INTERCEPT-MEAN F	1.4000	1.4764	1.0952	1.1030	1.0274	0.9916
		INTERCEPT-I ERROR	50/ 10	41/ 6	50/ 10	45/ 12	50/ 10	56/ 12
ERROR=100								
		SLOPE-MEAN F	1.5000	1.1325	1.1000	0.9563	1.0278	0.9734
		SLOPE-I ERROR	50/ 10	39/ 5	50/ 10	36/ 9	50/ 10	68/ 10
	FR	INTERCEPT-MEAN F	1.4000	1.2070	1.0952	1.0103	1.0274	1.1373
		INTERCEPT-I ERROR	50/ 10	40/ 9	50/ 10	47/ 8	50/ 10	41/ 5

LE 25 SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF , RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF STIMATE BASED ON A CORRELATION OF 0.90

		SAMPLE SIZE					
		N=5		N=13		N=39	
		EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
	SLOPE-MEAN F	1.5000	1.3880	1.1000	1.1667	1.0278	1.0786
	SLOPE-I ERROR	50/ 10	54/ 9	50/ 10	42/ 6	50/ 10	55/ 13
RR	INTERCEPT-MEAN F	1.4000	1.4573	1.0952	1.0328	1.0274	1.1175
	INTERCEPT-I ERROR	50/ 10	56/ 10	50/ 10	55/ 13	50/ 10	51/ 12
ERROR= 0							
	SLOPE-MEAN F	1.5000	1.4501	1.1000	1.1097	1.0278	1.0324
	SLOPE-I ERROR	50/ 10	52/ 7	50/ 10	56/ 14	50/ 10	47/ 14
FR	INTERCEPT-MEAN F	1.4000	1.4045	1.0952	1.1086	1.0274	1.0100
	INTERCEPT-I ERROR	50/ 10	48/ 12	50/ 10	50/ 8	50/ 10	56/ 14
	SLOPE-MEAN F	1.5000	1.3065	1.1000	1.1154	1.0278	1.0621
	SLOPE-I ERROR	50/ 10	56/ 10	50/ 10	43/ 8	50/ 10	46/ 7
RR	INTERCEPT-MEAN F	1.4000	1.5104	1.0952	1.0839	1.0274	0.9735
	INTERCEPT-I ERROR	50/ 10	45/ 5	50/ 10	47/ 9	50/ 10	54/ 7
ERROR= 33							
	SLOPE-MEAN F	1.5000	1.4552	1.1000	1.1090	1.0278	1.5058
	SLOPE-I ERROR	50/ 10	43/ 17	50/ 10	37/ 10	50/ 10	54/ 13
FR	INTERCEPT-MEAN F	1.4000	1.4270	1.0952	1.0286	1.0274	1.3705
	INTERCEPT-I ERROR	50/ 10	53/ 13	50/ 10	47/ 10	50/ 10	63/ 15
	SLOPE-MEAN F	1.5000	1.3529	1.1000	1.1135	1.0278	0.9075
	SLOPE-I ERROR	50/ 10	46/ 5	50/ 10	32/ 2	50/ 10	41/ 7
RR	INTERCEPT-MEAN F	1.4000	1.3202	1.0952	0.8984	1.0274	0.8923
	INTERCEPT-I ERROR	50/ 10	47/ 9	50/ 10	61/ 11	50/ 10	39/ 8
ERROR= 67							
	SLOPE-MEAN F	1.5000	1.1533	1.1000	0.8564	1.0278	1.2317
	SLOPE-I ERROR	50/ 10	25/ 3	50/ 10	25/ 1	50/ 10	54/ 13
FR	INTERCEPT-MEAN F	1.4000	1.0490	1.0952	0.8126	1.0274	1.1081
	INTERCEPT-I ERROR	50/ 10	38/ [illegible]	50/ 10	27/ 3	50/ 10	70/ 16
	SLOPE-MEAN F	1.5000	1.3439	1.1000	1.0831	1.0278	0.9835
	SLOPE-I ERROR	50/ 10	47/ 6	50/ 10	21/ 3	50/ 10	21/ 3
RR	INTERCEPT-MEAN F	1.4000	1.2008	1.0952	0.8364	1.0274	0.7992
	INTERCEPT-I ERROR	50/ 10	44/ 10	50/ 10	46/ 11	50/ 10	41/ 8
ERROR=100							
	SLOPE-MEAN F	1.5000	0.8014	1.1000	0.7567	1.0278	0.9633
	SLOPE-I ERROR	50/ 10	19/ 3	50/ 10	17/ 2	50/ 10	80/ 21
FR	INTERCEPT-MEAN F	1.4000	0.9509	1.0952	0.7204	1.0274	1.2824
	INTERCEPT-I ERROR	50/ 10	19/ 6	50/ 10	22/ 2	50/ 10	49/ 11

variable: (1) the concomitant variable is random rather than fixed; (2) the concomitant variable is fixed but contains error; and (3) the concomitant variable is random and contains error. The first of these three, which is a partial replication of the Calkins and Jennings (1972) study, can be examined by observing the results of the random and fixed sampling procedure (RN, random normal, and RR, random rectangular, versus FN, fixed normal, and and FR, fixed rectangular) for the various experimental conditions when the concomitant variable contains no error. The second aspect, the concomitant variable is fixed but contains error, can be examined by observing the results of the fixed sampling procedure (FN, fixed normal, and FR, fixed rectangular) for the various experimental conditions when the concomitant variable contains varying amounts of error. The third aspect, the concomitant variable is random and contains error, can be examined by observing the results of the random sampling procedure (RN, random normal, and RR, random rectangular) for the various experimental conditions when the concomitant variable contains varying amounts of error.

Examination of Tables 2-25 reveals that considerable variation occurs for the observed values (OBSERVED) obtained in the experiments. For the variance, skewness, and kurtosis of the distributions of intercepts and slopes, the means of the distributions of the critical statistics, and the number of Type I errors for intercepts and slopes, the observed values seem to vary about the expected values (EXPECT T and EXPECT 0) with no particularly important discernable pattern which can be attributed to the factors varied in the experiments, with one exception. The exception is evident for the distributions of intercept and slope for samples of size five where some of the values of skewness and kurtosis are of sufficient magnitude that it seems unlikely that these values are distributed normally. Thus it appears that neither (1) amount of error of estimate, (2) shape of the distribution of the

concomitant variable, (3) sampling procedure for the concomitant variable, (4) sample size (with the exception noted above), or (5) amount of error in the concomitant variable are related to any sizable disruption of (1) the critical statistics for contrasts of slopes and intercepts, or (2) the variance or normality of the distributions of the values of intercept and slope.

However, examination of Tables 2-17 reveals considerable disparity between expected values for central tendency for the distributions of intercept and slope (EXPECT T - MEAN), which are based on knowledge of the specified population parameters, and the corresponding observed central tendency values (OBSERVED - MEAN). Since the magnitude of this disparity increases with increasing amounts of error and seems unaffected by change in the other factors which were varied, it would seem reasonable to conclude that the estimates of the central tendency values for distributions of intercept and slope are disturbed by error in the concomitant variable. This conclusion, however, overlooks a crucial lack of control in the procedure - the lack of control over the variance of the concomitant variable after the introduction of the error component. When an expected central tendency value (EXPECT O) which was computed from the observed characteristics of the bivariate and marginal distributions is compared to the observed central tendency values, the magnitude of the discrepancy is greatly reduced, and the observed values again appear to vary about the expected values with no particularly important discernable pattern which can be attributed to the factors varied in the experiments. Thus it appears that when the results are viewed in such a way that the lack of control of the variance of the concomitant variable is compensated for, neither (1) amount of error of estimate, (2) shape of the distribution of the concomitant variable, (3) sampling procedure for the concomitant variable, (4) sample size, or probably (5) amount of error in

the concomitant variable is related to any systematic disruption of the estimates of the intercept and slope values.

CONCLUSIONS

In the mathematical treatment of linear models, certain of the independent variables are assumed to be fixed variables (Graybill, 1961). When this assumption is made, it can be shown that the computed estimates of the parameters occurring in the models have the desirable characteristics that they are "good" estimates and are normally distributed.

It is often convenient to overlook this assumption when linear models are utilized in a research situation, since the nature of a variable often does not allow the researcher to select cases with particular values of a variable without discarding large amounts of data. This empirical study was undertaken as an attempt to discover the effects produced for the computed statistics and for the decisions made on the basis of a critical ratio concerning differences in these statistics for a particular family of linear models when certain independent variables are not fixed variables.

The assumption that certain independent variables have fixed values can be violated in one or both of two ways: (1) the researcher can fail to preselect values of the variables which will be found in the data and utilized to estimate the statistics, and/or (2) measurement error can be introduced through the process of observing the values of the independent variables. Calkins and Jennings (1972) reported that when certain independent variables are not fixed but are observed without error, the consequences of the violation of the assumption are negligible. The present study focused on the effects produced when the concomitant variable is either fixed or random but measured with error.

The particular family of linear models investigated are a set presented by Ward and Jennings (1973, pp. 138-148), who apply them to problems generally

approached by the use of the technique of analysis of covariance. The estimable terms in these models represent the estimates of the parameters of intercepts and slopes of group regression lines.

Three cases of the violation of the assumption that the concomitant variable is a fixed variable were investigated in this study. These three cases were (1) the concomitant variable is fixed but contains error, (2) the concomitant variable is random (partial replication of Calkins and Jennings, 1972), and (3) the concomitant variable is random and contains error. Three types of consequences of these three departures from the assumptions were investigated: (1) the estimates of the slope and intercept parameters are not "good," (2) the distributions of the values of these estimates are non-normal, and (3) the number of erroneous decisions concerning differences in the estimates are greater than expected.

In general the results of this study indicate that little discrepancy was evident between the observed and expected number of Type I errors resulting from any of the three cases of violation of the assumption. In addition, for none of the three cases did the distributions of the values of intercept and slope appear to be distributed other than normally except for samples of size five. Although there were differences of considerable magnitude between some of the expected and observed estimates of the intercept and slope parameters which appeared to be associated with amount of error in the concomitant variable, these differences were probably due to lack of control over the variance of the concomitant variable, since when the expected values were calculated utilizing the actual variance of the concomitant variable the magnitude of these differences was considerably reduced. Thus it appears likely that for none of these three cases of violation of the assumption are the estimates of the population values of intercept and slope seriously affected.

Probably only the tentative conclusion that the violation of the assumption that the concomitant variable be fixed and contain no error presents little or no problem for researchers should be drawn from this investigation. Before firmer conclusions are justified, the investigation should be repeated with better control of the variance of the concomitant variable when it contains error.

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